THE Petroleum Engineer

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THE ENGINEERING MAGAZINE OF THE OIL AND GAS INDUSTRY

# This Issue Contains


## DRILLING AND PRODUCTION

| | Page |
|---|---|
| Shooting Practices in the Ritz-Canton Field, McPherson County, Kansas — By Van D. Bennett | 22 |
| Combination Portable Drilling Machine and Rotary Rig — By Gamaliel Graham | 30 |
| Reservoir and Producing Conditions in East Texas — By K. C. Sclater | 33 |
| Solving Well-Pumping Equipment Problems — By Hyman Ledeen | 54 |

## REFINING AND NATURAL GASOLINE MANUFACTURING

| | |
|---|---|
| Manufacture of Special Products from Crude Distillation Units — By T. B. Leech | 20 |
| Cracking — By W. L. Nelson | 27 |
| Some General Properties of Clays Used in Contact Treating — By L. C. Trescott | 44 |
| Expansion Anchor for Pipe — By M. C. Cockshott | 61 |

## OIL AND GAS TRANSPORTATION

| | |
|---|---|
| Design of Marine Oil Terminals — By M. C. Cockshott | 18 |
| Toledo-Detroit Gasoline Line Completed — By Warren L. Baker | 26 |
| Preventing Hydrometer Breakage in Pipe Line Stations — By S. C. Dillman | 60 |
| Submerged Pipe Line Facilitates Loading of Tankers — By Wallace A. Sawdon | 62 |

## REGULAR DEPARTMENTS

| | |
|---|---|
| The Course of Oil | 9 |
| Highlights in Oildom | 10 |
| Latest Activities in the Oil Fields | 12 and 13 |
| Progress of Major Pipe Line Work | 14 |
| The Month's Activities in Refining | 17 |
| Strange But True | 43 |
| New Petroleum Equipment | 47 and 48 |
| Running Tour with Men in the Industry | 51 |
| Laugh with Barney | 53 |
| New Books of the Trade | 64 |


# Meetings

The American Society of Mechanical Engineers and Sixth National Oil and Gas Power Meeting—Atlantic City, N. J., August 23 to 26.

•

Society of Automotive Engineers—Chicago, August 28 to September 4.

•

American Chemical Society—Stevens Hotel, Chicago, September 10 to 15.

•

American Gas Association, International Gas Conference and 15th Annual Meeting—Stevens Hotel, Chicago, September 25 to 30.

•

A. I. M. E., Petroleum Division, Mid-Continent Section—Baker Hotel, Dallas, October 6 and 7. Western Section — Los Angeles, October 6 and 7.

•

American Petroleum Institute, Annual Meeting—Stevens Hotel, Chicago, October 24 to 26.

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# The Course of Oil

By K. C. SCLATER

**Embarking on a Great Experiment**

SHARPLY conflicting views have developed in drafting a code of fair practice for the oil industry. After the first code drafted at Chicago by representatives of the oil industry was discarded, Gen. Johnson undertook to write one. When that was submitted at Washington to representatives of the oil industry differences developed that could not be reconciled, wherefore the Government again took unto itself the task of revising the controversial sections of the tentative code. Meanwhile, the oil industry, awaiting acceptance of the code and anticipating many changes under the new industrial regime, has been lulled into another period of uncertainty. It must continue to mark time until agreement is reached on the cardinal provisions in dispute and the code accepted and approved. Once the code is adopted, it will be the guiding instrument by which the oil industry will conduct itself, for the next two years at least, and its compliance by all operators in all branches of the industry will become imperative.

Two of the principal points at issue are price regulation and control of production. Of vital concern to the production, transportation and refining branches of the industry, these two topics have become salient points for a clash of opinion between proponents and opponents of Federal regulation. In the tentative code prepared by Gen. Johnson, and now under revision, price regulation was omitted. He holds to the theory that by maintaining a proper balance between supply and demand the price situation will take care of itself and is against price regulation until the effect of production control on prices has been determined.

In the blanket code of the Recovery Act the question of price involves consideration of producers, labor and the public. Among other things, the code is designed to increase employment and improve the working conditions of the man in the field by reducing the maximum hours of labor and increasing the minimum hourly wage scale. If, as has been estimated, the labor provision in the tentative code will increase the annual payroll of the oil industry $250,000,000, the equivalent increase in combined unit cost (including production, transporting, refining and marketing) will be 30 cents a barrel, based on a daily production of 2,100,000 barrels of crude. Many companies, both majors and independents, now operating on a slender margin of profit, and many more still operating at a loss under the prevailing low crude prices, naturally are concerned about what may happen if, under the workings of the code, crude prices fail to increase. With no price regulation, dependence must be placed on curtailing production to demand for a price increase, without which higher wages, shorter hours and increased employment as required by the code cannot be met.

As a compromise in the controversy over price regulation, inclusion of the provision that no crude shall be sold below the cost of production seems likely. This may necessitate determining the cost of production for different fields or districts, and may be a difficult, but not an insuperable, problem. Since one of the purposes of the code is to provide some protection for the 300,000 stripper wells in the country, the difference in unit cost of production between these and flush wells may also have to be adjusted by some equitable means. Many efficient methods of production and well operation are available to producers today, and it may be that the difference in unit cost between a barrel of oil produced from a well in a flush field and that produced from a stripper well is not so great as is generally assumed. The amount of capital investment may enter as an important factor. It will not do to adjust unit cost down to the level of the lowest or up to that of the highest; a compromise must be effected that will require the inefficient operator to improve his methods of operation, and reward the alert operator who obtains an advantage solely through the adoption of more advanced producing practices that, besides complying with the code, promote conservation in the true sense of the term—that is, producing a barrel of oil at the lowest unit cost with such an expenditure of natural energy that will lead to a greater ultimate recovery of oil. It will be found that provisions of the code are likely to be such as to encourage the prudent operator to increase the efficiency of his operations and to require, if not compel, the imprudent operator to do likewise.

The National Industrial Recovery Act, being a drastic measure, may bring about drastic changes. Comprehensive in its scope, the code will affect every phase of the industry. If and when unfair practices are prohibited and really become taboo, healthy competition will assert itself and efficient operation will be rewarded. Despite the dire predictions on the outcome of Federal control, an exigency has forced it, and oil, in common with all industry in the United States, can not escape it. In these circumstances it is to be hoped that the oil industry will really grow and prosper under the new order. Much of what will be written into the adopted code will be revolutionary, and, in many respects, depart so greatly from present business standards that there will be many misgivings until the efficacy of the code has been tested in actual practice. At any rate, after two years, the oil industry will have the opportunity of discarding the code entirely, or of eliminating the bad features, retaining the good and adopting them as a permanent code for guidance and regulation. A great experiment will have been made that should prove or disprove many theories, solve many perplexing problems, and teach some valuable lessons without going through the many vicissitudes that so often attend the normal course of industrial progress.

# « « « HIGHLIGHTS IN OILDOM » » »

**Revise East Texas Allowable**

The completion of 169 wells in East Texas since July 16, which brings the total number in that area to 10,300, has resulted in the Texas Railroad Commission announcing a new allowable of 598,052 bbl. daily for the field. This allowable will permit an average daily production of 57.9 bbl. per well per day.

●

**Texas State-Wide Proration Hearing**

Texas, the crucial factor in the crude oil situation, because of its production of 1,000,000 bbl. daily, will hold a very important meeting on August 21, a State-wide oil proration hearing before the Railroad Commission. By that time the Federal policy will probably have been fixed and the national code adopted. Any changes following this hearing are expected to effect conformation to the Federal code and set field allowables to conform with the total top allowable assigned the state by the national administrator.

●

**Purchasers Agree on Crude Oil Price**

Virtually all the active purchasers of crude oil who recently sought to raise prices have reverted to the levels established by the Standard Oil Companies of Indiana and New Jersey. Under the new schedules prices range from 28 to 52 cents in North Central and East Central Texas; from 45 to 65 cents in Gray County, Texas; from 35 to 55 cents in the Texas Panhandle; from 30 to 62 cents in Oklahoma and Kansas, with a flat price of 50 cents posted in East Texas.

●

**Federal Government Bans "Hot Oil" Shipments**

Regulations signed by President Roosevelt have prohibited shipments in interstate commerce of oil produced in defiance of state proration orders. Immediately after the signing of this proclamation, Federal deputies were sent to the East Texas field. The result was the stopping of "hot oil" shipments with dramatic suddenness and, consequently, the output from the East Texas oil field fell for the first time to the allowable figures established by the Texas Railroad Commission. A marked change in policy on the part of violators was noted when it was two weeks before a suit, now pending, was filed to test its legality. The suit, the first and only attack yet made on any feature of the recovery act, asserts that President Roosevelt's proclamation against interstate shipments of "hot oil" is unconstitutional in that it seeks to give the president legislative power that rests in Congress.

●

**Industry Fails to Adopt Code**

With agreement on the most debatable provisions of the oil code almost in sight after 10 days of wrangling, hearings before the National Recovery Administration came to a termination abruptly on August 3, when the National Emergency Committee of 54 refused to approve production provisions that, on the previous day, had been submitted with unanimous approval. Following this development, the several factions were again as far apart as ever on the subjects of government production control and price regulation. Deputy Administrator K. M. Simpson adjourned the hearing and asked the several committees to make new efforts to develop a satisfactory code. The hearing was adjourned subject to call from Simpson. The Committee of 54 desires to include a clause giving the president authority to compile pool and lease production quotas that shall form the operating basis for any state failing to limit its output to the allocation proposed by the government. Another question under dispute was whether a minimum price for crude oil should be established. Labor provisions and the general marketing code appear to remain satisfactory to all interests.

●

**Pipe Lines Held Common Carriers**

Pipe lines are subject to the statutes regulating common carriers and their operators are required to make reports, while refineries, on the contrary, are not in accordance with two opinions handed down by a three-judge Texas Federal Court.

The Railroad Commission's right to require reports was upheld in the case of the Atlas Pipe Line Company. In the case of the Overton Refining Company and others the plaintiffs were said to have been subjected to burdensome if not confiscatory requirements and the commission was held to have exceeded its authority in going on the premises, examining books and gauging tanks of refiners.

●

**Oklahoma Curbing "Hot Oil" Shipments**

Seeking to curb interstate shipments of illegally produced oil from Oklahoma fields, Federal and state officials and oil company representatives have decided to recommend that detailed reports be required from producers and purchasers of crude oil before shipments are made. The recommendations will be presented to Secretary Ickes for approval. The affidavits would require from both producers and purchasers information as to where the oil was produced, the quantity, names of purchasers and producers and methods of transportation. Railroads and pipe line companies would be prohibited from transporting petroleum until they furnished the State Corporation Commission and the Federal government with this information. Reports would be made daily or monthly, depending upon the nature of the shipment.

●

**Court Upholds Conroe Proration**

A three-judge Federal Court has denied complainants an injunction, which they sought against the Texas Railroad Commission and others in connection with proration enforcement in the Conroe, Texas, field. The proration order was attacked as unreasonable because it is based on acreage rather than well potentials. The court held the order as being reasonable and valid.

●

**Crude Output Still Excessive**

The virtual elimination of proration violations in the East Texas field during the last two weeks of July was not sufficient to bring the United States' crude oil output within the amount being consumed. Figures of the American Petroleum Institute for the month of July show that approximately 300,000 bbl. daily was produced in excess of the amount consumed, consequently, stocks of crude oil, already excessive, were further increased. Output for the United States averaged 2,651,400 bbl. daily for the month of July.

The American Petroleum Institute's committee on refinery statistics and economics recently estimated that the total requirements for domestic crude oil during the last six months of 1933 would average 2,362,000 bbl. daily. This figure, in the face of crude oil production during the past three months, would indicate that a downward revision of allowable output is needed.

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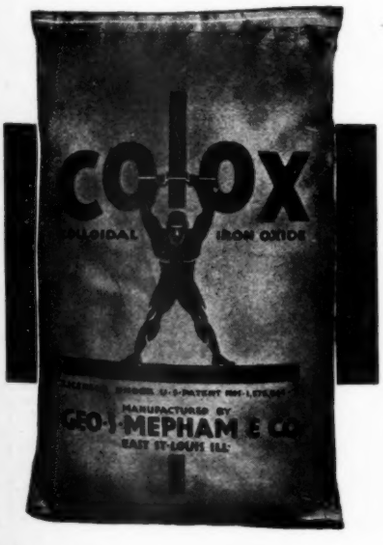


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# LATEST ACTIVITIES IN THE OIL FIELDS

A new discovery in the Crescent area of Logan County, Oklahoma, is being ranked as the most important oil strike in that state since the opening of the Oklahoma City field in December, 1928. Because of the lack of new reserves in the state the pool is attracting much attention and will increase the extensive exploration of the central part of Oklahoma, where many concerns are now seeking production. The discovery well, Gypsy Oil Company and Carter Oil Company's McConnell 1, Section 27 17n-4w, produced 5736 bbl. of 42.1 deg. gravity oil during the first 24 hours and during the second and third day made 5725 and 5381 bbl. respectively. The gas flow is approximately 6,000,000 cu. ft. per day.

•

The Wentz or Perry field of Noble County, Oklahoma, had its first dry hole as Shell Petroleum Corporation, et al., encountered a hole full of water at 5385 ft., and were unsuccessful in plugging it off. Many wells in this district are drilling at interesting depths and during the next month it should definitely be determined whether or not the pool is a prolific one.

•

New operations in south Texas continue to increase. Duval County remains as the leader in active operations, but Refugio County leads from the standpoint of first reports. The main activity in the latter county surrounds three wells in the new Greta field, where immediate offsetting is required. Completions in the North Government Wells field, Duval County, continue to include a number of producers in outlying districts that are extending the producing area of the pool to the north and south.

•

Several wells in Tomball, north of Houston, the most sensational spot along the Texas Gulf Coast, are being closely watched as they near critical depths. Estimates as to the possible potential size of this field have been reduced because of the disappointment in finding only gas in the Magnolia Petroleum Company's Rudel 1 and the encroachment of water in several of the wells.

•

The recently discovered Livingston pool in Polk County received another producer when Shell Petroleum Corporation completed a well for 785 bbl.

•

Santa Rita Oil Company et al's, Jacobson 1 well is pumping 55 bbl. daily and has definitely proved the North Cut Bank structure, now called the Stewart pool, 12 miles north of the Cut Bank field, Montana. It is producing from a depth of 2603-16 feet.

•

A spectacular rush to file intentions to drill new wells has been the most important development in California during July. A total of 224 permits were filed during the past 30 days, which constitutes a record for the state. One hundred and four of these were made in one week. The sudden increase of notices of intention to drill new wells does not constitute a commencement of drilling oprations and it will be a long time before actual drilling is started on the majority of these tests. The state of California recently announced it would require a $5000 bond with each notice of intention to drill and this development has brought about the forementioned condition.

•

Salt water appeared in the Sabine Production Company's test three-fourths of a mile northwest of production in the shallow Converse pool of Sabine Parish, La., when swabbing was commenced at a depth of 3061 feet. The well had a good showing of oil and gas. It is possible that a bad casing seat or parted casing is permitting water to enter the hole, but only further tests can definitely determine the source of the water.

### AVERAGE CRUDE OIL PRICES

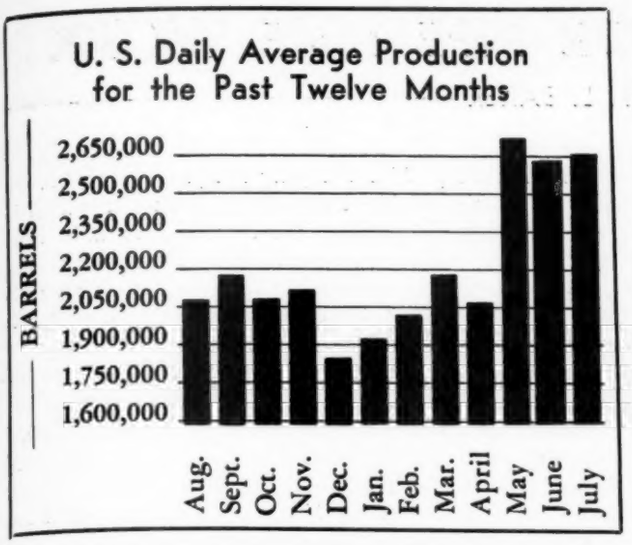
| | | | |
|---|---|---|---|
| California | | Arkansas | $ .30 |
| Playa Del Rey | $ .76 | Louisiana | |
| Coalinga | .52 | North Louisiana | .54 |
| Long Beach | .85 | Gulf Coast | .54 |
| Montana | .80 | Illinois | .77 |
| Wyoming | .54 | Kentucky | .72 |
| Colorado | .54 | Indiana | .95 |
| New Mexico | .30 | Ohio | |
| Texas | | Lina | .85 |
| North Central | .54 | Wooster | .70 |
| Panhandle | .38 | Michigan | .90 |
| West Texas | .30 | Pennsylvania | |
| Gulf Coast | .54 | Bradford | 1.85 |
| Darst Creek | .40 | Corning | .90 |
| East Texas | .50 | West Virginia | 1.47 |
| Kansas | .54 | Canada | 1.75 |
| Oklahoma | .54 | | |

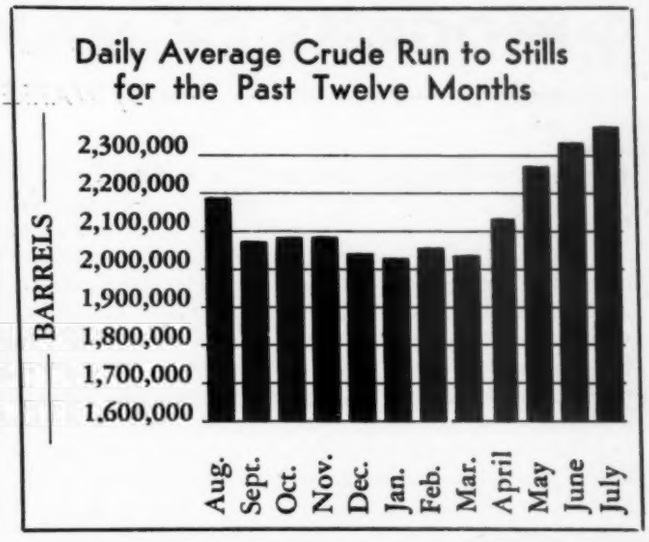
### DAILY AVERAGE PRODUCTION[1]

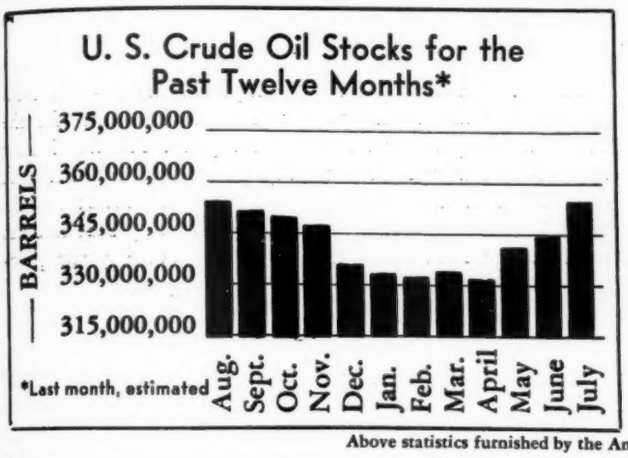
(Figures in Barrels)

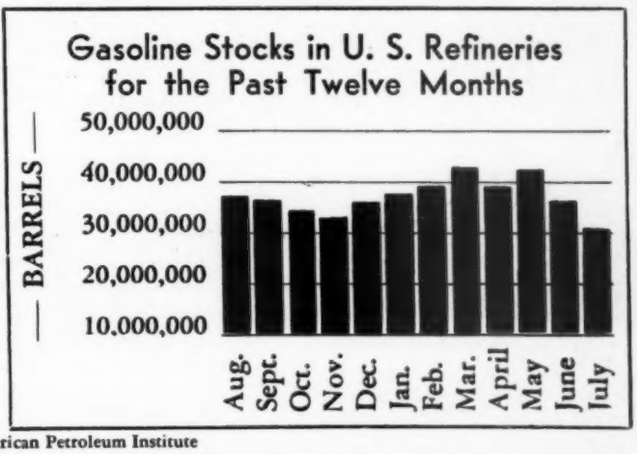
| | Week Ended July 29 1933 | Week Ended June 24 1933 | Week Ended July 30 1932 |
|---|---|---|---|
| Oklahoma | 600,600 | 530,650 | 394,550 |
| Kansas | 125,500 | 110,400 | 96,050 |
| Panhandle Texas | 55,600 | 42,900 | 56,850 |
| North Texas | 50,750 | 47,050 | 49,950 |
| West Central Texas | 21,850 | 19,250 | 24,250 |
| West Texas | 158,200 | 156,900 | 178,300 |
| East Central Texas | 58,400 | 58,600 | 57,950 |
| East Texas | 583,650 | 565,250 | 330,600 |
| Conroe | 84,100 | 60,250 | 1,200 |
| Southwest Texas | 52,600 | 50,850 | 57,000 |
| North Louisiana | 26,050 | 24,500 | 29,900 |
| Arkansas | 31,250 | 30,300 | 34,150 |
| Coastal Texas (Not including Conroe) | 125,750 | 116,000 | 118,950 |
| Coastal Louisiana | 46,450 | 40,500 | 31,650 |
| Eastern (Not including Mich.) | 93,100 | 88,200 | 103,950 |
| Michigan | 19,950 | 15,200 | 18,350 |
| Wyoming | 29,700 | 29,250 | 38,200 |
| Montana | 7,250 | 6,650 | 7,700 |
| Colorado | 2,400 | 2,400 | 2,850 |
| New Mexico | 37,600 | 36,000 | 35,900 |
| California | 487,100 | 482,500 | 469,200 |
| TOTAL | 2,697,850 | 2,513,600 | 2,137,500 |
| Texas | 1,190,900 | 1,117,050 | 875,050 |

[1]Production figures furnished by the American Petroleum Institute.




Above statistics furnished by the American Petroleum Institute

## Summarized Operations in Active Fields for July, 1933

| Fields | Completions | Producers | Locations | Rigs | Drilling Wells | Depth of Production | No. Casing Strings | Gravity of Oil | Type of Tool Used |
|---|---|---|---|---|---|---|---|---|---|
| Texas | | | | | | | | | |
| East Texas | 115 | 114 | 228 | 35 | 67 | 3600 | 2 | 40 | Rotary |
| Duval County | 25 | 18 | 55 | 4 | 11 | 2300 | 2 | 22 | Rotary |
| Conroe | 45 | 43 | 26 | 7 | 49 | 5200 | 2 | 38 | Rotary |
| Oklahoma | | | | | | | | | |
| Oklahoma City | 3 | 2 | 8 | 25 | 19 | 6500 | 3 | 39 | Rotary |
| Kansas | | | | | | | | | |
| McPherson County | 12 | 8 | 30 | 4 | 25 | 2900–4300 | 2 | 38 | Rot.-Cab. |
| Ellsworth Arch | 8 | 8 | 23 | 7 | 25 | 3300 | 4 | 37 | Cable |
| Harvey County | 9 | 9 | 22 | 6 | 19 | 3450 | 2 or 4 | 37 | Rot.-Cab. |
| California | | | | | | | | | |
| Kettleman Hills | 2 | 2 | 1 | 0 | 12 | 8300 | 3 or 4 | 40 | Rotary |
| Long Beach | 5 | 5 | 20 | 6 | 25 | 7000 | 3 | 26 | Rotary |

## Field Activities by States for July, 1933

| State | Completions | | Producers | | Locations | | Rigs | | Drilling Wells | | Production, 1932 (In Barrels) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | July | June | July | June | July | June | July | June | July | June | |
| Arkansas | 7 | 4 | 0 | 0 | 3 | 0 | 11 | 9 | 32 | 30 | 11,907,000 |
| California | 23 | 18 | 22 | 16 | 282 | 59 | 35 | 24 | 131 | 134 | 178,128,000 |
| Colorado | 3 | 1 | 0 | 1 | .... | .... | 5 | 5 | 55 | 57 | 1,177,000 |
| Illinois | 2 | 1 | 0 | 1 | .... | .... | 1 | 1 | 12 | 11 | 4,661,000 |
| Indiana | 2 | 16 | 3 | 9 | .... | .... | 2 | 1 | 53 | 57 | 804,000 |
| Kansas | 44 | 30 | 32 | 20 | 84 | 37 | 21 | 24 | 151 | 167 | 34,300,000 |
| Kentucky | 15 | 11 | 8 | 3 | .... | .... | 3 | 1 | 50 | 50 | 6,264,000 |
| Louisiana | 45 | 32 | 21 | 15 | 117 | 70 | 35 | 68 | 145 | 113 | 21,478,000 |
| Michigan | 20 | 7 | 12 | 6 | 45 | 24 | 45 | 46 | 84 | 73 | 6,729,000 |
| Mississippi | 4 | 6 | 2 | 2 | .... | .... | 4 | .... | 14 | 14 | Gas Prod. |
| Montana | 2 | 2 | 2 | 2 | .... | .... | 3 | 4 | 36 | 35 | 2,449,000 |
| New Mexico | 0 | 3 | 0 | 2 | .... | .... | 8 | 5 | 51 | 51 | 12,511,000 |
| New York | 0 | 4 | 0 | 4 | .... | .... | 5 | 10 | 17 | 19 | 3,501,000 |
| Ohio | 48 | 31 | 41 | 19 | .... | .... | 25 | 40 | 119 | 151 | 4,597,000 |
| Oklahoma | 69 | 68 | 41 | 44 | 107 | 72 | 83 | 75 | 285 | 264 | 152,621,000 |
| Pennsylvania | 8 | 14 | 3 | 13 | .... | .... | 8 | 13 | 68 | 48 | 12,403,000 |
| Texas | 358 | 313 | 249 | 218 | 744 | 455 | 116 | 145 | 620 | 637 | 311,069,000 |
| West Virginia | 16 | 18 | 13 | 12 | .... | .... | 25 | 20 | 54 | 43 | 4,472,000 |
| Wyoming | 2 | 4 | 1 | 3 | .... | .... | 10 | 10 | 63 | 57 | 12,359,000 |
| Total | 668 | 583 | 450 | 390 | 1382 | 717 | 445 | 501 | 2040 | 2011 | 781,845,000 |

# PROGRESS OF MAJOR PIPE LINE WORK

By WARREN L. BAKER

STANOLIND PIPE LINE COMPANY has awarded contracts for the laying of 79 miles of 10- and 12-in. pipe for building a transmission system extending north, south and east by south from Houston, Texas. A part of this project is to consist of a 31-mile, 12-in. extension from Sinco terminal, near Houston, eastward to the Texas City refinery site of the Pan-American Refining Corporation. The Apex Construction Company will be in charge of construction work on this section of the line and has commenced ditching and laying operations. Kelly-Dempsey Company was awarded the contract for building 42 miles of 10-in. line south from the Hufsmith station, north of Houston, to the Baytown tank farm and refinery of the Humble Oil & Refining Company. All work is to be completed by September 2. Extension of the company's trunk facilities to Baytown will supply the Humble refinery with crude for processing until the Texas City refinery is completed. Upon completion of the entire expansion project the Texas City plant will be supplied East Texas crude oil by a direct line.

●

Meador & Whittaker and Truman-Smith Construction Company, contractors on the Sinclair-Prairie Pipe Line Company expansion work in South Texas, have completed their work and the unit is ready for operation. This gives the company facilities to pump 75,000 bbl. of crude daily from the East Texas field direct to the Sinclair Refining Company's refinery and tank farm at Sinco, on the Houston Ship Channel. A total of 140 miles of 12-in. pipe was laid from Colonels station, near Mexia, to Huffman station, north of Houston. A 12-in. line already was in service between the East Texas field and Colonels station and between Huffman and Sinco.

●

Sun Pipe Line Company has requested contractors to bid on the extension of its crude oil transportation system in the Humble, Texas, field to the Conroe field, Montgomery County, Texas, a distance of 17 miles. The company owns more than 20 wells in the Conroe pool and has an allowable of 3100 bbl. daily. The line will probably consist of 6-in. pipe, so that the output from additional wells may be handled.

●

An extension until December 31, 1933, of the optional contract under which natural gas may be brought to Detroit, Michigan, has been granted by the Detroit Common Council after S. M. Dunbar, with Benedum-Trees Company, Pittsburgh, Pa., and J. W. Rice of Dayton, Ohio, reported that progress is being made on engineering phases of the project. These men reported that the company has available a supply of natural gas adequate for Detroit's consumption for 50 years. The company proposes to bring gas from Utica, Kansas, and areas in the Texas Panhandle, as well as to use gas produced in the fields of Michigan. A branch line will probably be laid to Detroit from Rockville, Indiana, where gas from the Kansas and Texas fields already is available.

The Texas Pipe Line Company is laying a new 6-in. oil pipe line in the Wichita Falls, Texas, area to serve fields in Young and Jack counties. The new line, 15 miles long, will start from the pool two miles northwest of Bryson in Jack County, and run west to the James pool, six miles east of Newcastle in Young County, where it will take production from this new area.

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A. Thomas Sarkisson, president of the Michigan Natural Gas Corporation, has announced that construction work will be under way within 30 days on 157 miles of natural gas line from the fields of central Michigan to Pontiac and Flint, with spur lines to Bay City and Saginaw.

●

Ford, Bacon & Davis have completed the 80-mile 6-in. gasoline pipe line from Toledo to Detroit, Michigan, for the Pure Oil Company and the Sun Company. The line is now being placed in operation to ship gasoline from the Toledo refineries of the two companies to a terminal built at Detroit. From Detroit motor fuel may be distributed by boat to cities on the Great Lakes, thus the new transporting system practically makes the Toledo refineries seaport plants.

●

Further indications that foreign oil fields may soon prove more considerable factors in international petroleum markets are evident from reports that the building of a pipe line in Transcaucasia will soon be commenced. The line will link the Malye Shiraki oil field with the Kukhti station on the Transcaucasian railway and will be capable of transporting 600,000 tons annually.

●

The Benedum-Trees Oil Company of Pittsburgh, Pa., proposes to construct a natural gas line from Clyde, N. Y., to several towns in that vicinity. Franchises in Wolcott, Sodus, Williamson, Ontario, Savannah, Port Byron and Weedsport are being sought. Estimated cost of laying the line from the Welch gas producing well through the village of Clyde is approximately $80,000.

●

Completion of the eighth gas well in the field southeast of Carlisle, Indiana, has again started rumors that natural gas will soon be piped to the near-by communities of Carlisle and Oaktown. Both towns are now considering franchises. It is estimated the eight wells in the field have a total producing capacity of 20,000,000 cu. ft. per day.

●

The Texas Railroad Commission has again postponed its hearing on pipe line rates, storage and strappage charges. The hearing is now scheduled for August 21. It was announced that the case would not be held on July 31 because the NRA code had not been completed and pipe line companies did not know what course would be necessary in the future.

# THE MONTH'S ACTIVITIES IN REFINING

By F. R. STALEY

## Per Cent Refining Capacity Operated

**Eastern Division 81.0 Per Cent** **Central Division 72.3 Per Cent** **Western Division 57.1 Per Cent**

IT is anticipated that with increased buying power and the loosening of credits many refiners will feel more free to spend funds to modernize their plants so as to take advantage of newly developed and more economical manufacturing proccesses. It is thought that a large number of refiners are almost a year behind with their purchases of equipment and that several refineries, especially in the area supplied with East Texas crude will install cracking units for the reason that as the field shows a natural decline in crude production and prices are correspondingly advanced, including refined products, the relatively large surplus of fuel oil in the district makes cracking an attractive consideration. There is every reason to believe that the refining industry is ready for a new expansion in modernization of existing plants that will prove to be on profitable operating lines.

●

Imperial Chemical Industries, Ltd., will start the immediate construction of a $12,000,000 hydrogenation plant near Middlesborough, England, for the production of gasoline and other refined oils from coal, according to dispatches from London. The British Government recently granted a minimum preference of fourpence (8 cents U. S.) per gallon in favor of gasoline manufactured from British coal for a period of 10 years.

●

Construction work on Pan-American Refining Company's Texas City, Texas, refinery is progressing favorably, and it is expected that the plant will be completed and in operation by April, 1934. The refinery is being equipped with cracking equipment by the M. W. Kellog Co., and will have a capacity of 32,000 bbl. daily. Storage for approximately 2,000,000 bbl. of crude oil and refined products will be erected at the plant. Two marine docks for loading ocean-going tankers are to be built.

●

The Spartan Refining Company, subsidiary of the Atlas Pipe Line Co., Inc., Shreveport, La., has awarded a contract to Alco Products Co., Inc., for the construction of a 2,000-bbl. Gyro cracking unit at its Jewella, La., refinery. The Spartan Company expects to modernize this plant completely through a series of improvements. It operates on East Texas crude oil.

●

A new stabilizer tower has been shipped from the C. F. Braun & Co., plant in California to the Shell Petroleum Corporation refinery at East Chicago, Indiana, where it will be used in connection with a Dubbs cracking installation.

●

Union Oil Company, Mills Bldg., San Francisco, Calif., is having plans prepared and will soon call for bids for an addition to its lubricating plant at Oleum, Calif. A contract for the erection of tankage has been given to the Berkeley Steel Construction Company of Berkeley, Calif.

●

What is said to be the largest shop-assembled riveted cracking tower made to date has been erected at the Globe Oil & Refining Company's Lemont, Ill., plant. Made by the Graver Tank & Mfg. Corp., it was shipped by railroad to the plant site. The weight of the unit was 232,400 lb., handled on a triple load. The overall diameter was in the neighborhood of 13 ft. 10 in., and the problem of handling it at the plant and of shipping it was of great complexity. The tower itself contained 14 steel bubble decks, one trap-off deck, together with a large heat exchanger that was in the chamber at one end. In transporting the unit all the brasses and springs on the three railroad cars were broken and the railroad calculations were so close that the clearance on one of the bridges enroute was less than ⅜ inch.

●

Hagy, Harrington & Marsh of Amarillo have a 60,000,000-ft. gasoline plant under construction near Pampa, Texas.

●

The recently organized Gregg-Tex Gasoline Corp. of Delaware will build a 24,000-gal. natural gasoline plant, capable of handling up to 10,000,000 cu. ft. of gas per day, at Willow Springs, in the East Texas field. The contract for the design and erection of the plant has been awarded to the Arthur G. McKee Company. The plant equipment will be of the most modern design throughout and will embody the principle of vapor rectification.

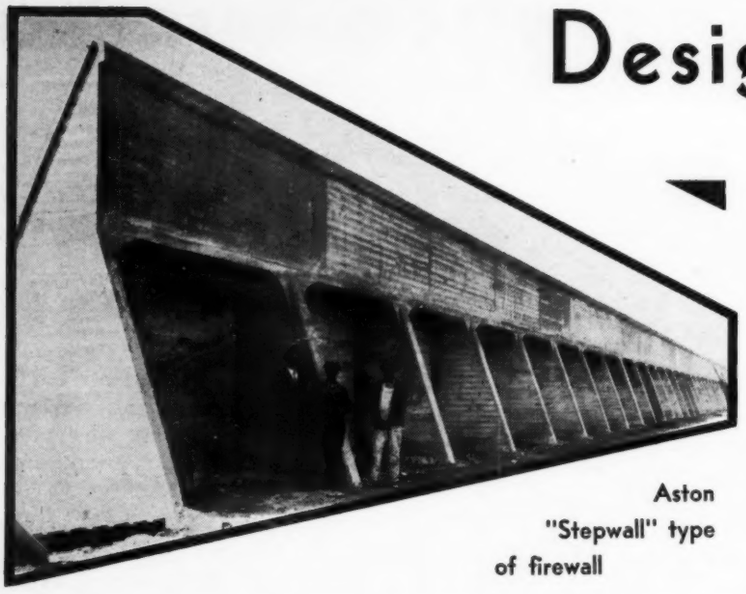
**Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending July 29, 1933**

**A.P.I. Figures**

**(Figures in Barrels of 42 Gallons Each)**

| DISTRICT | Per Cent Potential Capacity Reporting | Daily Avg. Crude Runs to Stills | Per Cent Operated of Total Capacity Reporting | Total Motor Fuel Stocks Thousands of Bbls. | Gas and Fuel Oil Stocks |
|---|---|---|---|---|---|
| East Coast | 100.0 | 497,000 | 85.4 | 15,158 | 7,871 |
| Appalachian | 92.6 | 104,000 | 74.4 | 2,009 | 806 |
| Ind., Ill., Ky. | 97.3 | 354,000 | 83.3 | 7,453 | 4,645 |
| Okla., Kans., Mo. | 82.1 | 269,000 | 70.9 | 4,640 | 3,833 |
| Inland Texas | 58.7 | 100,000 | 62.1 | 1,475 | 1,922 |
| Texas Gulf | 98.0 | 428,000 | 86.0 | 5,257 | 6,977 |
| Louisiana Gulf | 100.0 | 121,000 | 74.7 | 1,337 | 1,885 |
| N. Louisiana-Ark. | 92.6 | 52,000 | 68.0 | 268 | 539 |
| Rocky Mountain | 78.8 | 37,000 | 58.2 | 1,042 | 765 |
| California | 96.9 | 462,000 | 56.2 | 14,083 | 100,218 |
| Total July 29, 1933 | 92.2 | 2,424,000 | 73.3 | 52,722 | 129,461 |
| Total July 22, 1933 | 92.2 | 2,387,000 | 72.1 | 51,936 | 128,487 |

# Design of Marine Oil Terminals



Aston "Stepwall" type of firewall

IN the design of the modern marine oil terminal simplicity of operation is the dominant factor, and to achieve this the designer must have a practical knowledge of operating conditions, whereby accessibility, combined with simplicity, may be employed to the best advantage. During the stages of laying out the plant it may be very beneficial to have the superintendent who is to operate the plant on hand, as often points arise regarding which his experience is of value, and during construction he should be at all times on the job, watching, and getting acquainted with all operations of construction; in fact, if the work is being done by contract, the man who is to run the terminal may be used advantageously as inspector of the work.

To start from the beginning in the building of a marine oil-loading terminal, after having ascertained the quantities of oil to be handled and how much black and white (oil and gasoline), a preliminary layout is made to get the location of tankage, pumphouse, and dock to the best advantage available on the property. Having determined approximately these factors, it may be well to follow out the whole work point by point, beginning with the dock or pier.

The dock should be of sufficient length to take care of the largest tankers that may be used in that locality; many terminals have been cramped by not allowing facilities for future expansion. A dock that is 325 ft. long with two mooring dolphins at either end spaced 25 ft. apart will give a total of 425 ft., which will take care of the largest tankers. To facilitate mooring there should be some deadmen ashore over a space of about 600 ft.—four are usually sufficient—and these should be buried deep enough that they will not pull out—usually a heavy block of concrete with a chain and hook will suffice. The mooring dolphins should be of at least 13-pile construction, and securely wired together, usually local harbor ordinances will determine their design. In order to facilitate mooring a ship a catwalk should extend from the end of the dock to each dolphin.

The type of dock may vary, depending on the amount of business to be done, either a Tee-head type or, if a large trucking business for case or barrel goods is expected, one with two or more approaches will be needed. The location of the loading lines should be such that the dock is clear of all encumbrances and may be placed either on the back of the dock, or underneath. Wherever they are, care must be taken that they are not tied to the dock, that is, if on the back they should be laid so that they are free to slide with the movement of the dock, and expansion of the pipes, or if underneath, they should be hung so that they are free to swing. The width of the dock should in no case be less than 25 ft., as it makes the handling of heavy hose very difficult if the dock is narrow.

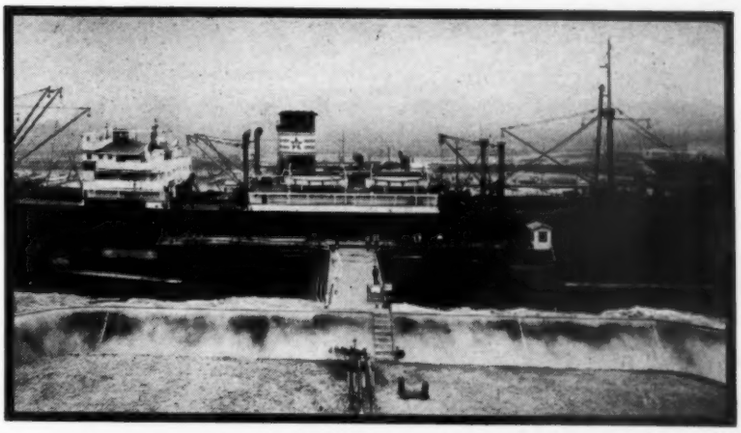
The number of lines, of course, depends on the different grades of gas and oil to be handled, for a dock of the aforementioned size each line will need three loading nozzles, spaced about 30 ft. from the dock ends and one amidship, as tankers vary in the location of their intake valves. These loading nozzles are best placed on the back of the dock, and consist of a riser, valve, and either a Y fitting on an ell, or in the case of a gas-oil line, a manifold with two or three smaller outlets to take care of several small lines whereby the double bottom and deep tanks of the vessel may be loaded at the same time. Each nozzle usually is equipped with a pressure gauge and vent, also an air connection for blowing back the line free of oil on completion of loading. The dock should also be equipped with a steam line sufficient to run the ships auxiliaries whilst unloading or loading gasoline, as all fires are drawn when at a gasoline dock. Water and air piping are also needed, with a meter on the former so that a tanker may be charged with what she takes.

To handle the hose, it is necessary to have a mast with derricks, and a small contractors type of hoist run either by air or electricity. The design of this should be studied carefully, as it must be of sufficient capacity to handle the hose at each nozzle; in fact, there should be one for each of the nozzle locations—two will be enough—and placed so that one of them will handle the midship loading nozzle in addition to the end one. An electric plug of about 80 amperes will be needed, whereby a line may be plugged in to the ship when at dock, with arrangements for metering the power supplied. The dock must be efficiently lighted, so that work at night will not be retarded, and all fittings, plugs, and receptacles must be of explosion-proof type. Foamite or other fire prevention systems must be led to dock, as also there must be several gallon fire extinguishers. Usually the fire prevention system will be determined by local ordinances governing the port. Bollards and cleats are necessary, especially the latter, as there are always a number of lines to be made fast.

A tool room on the dock is an asset, as there must be kept an assortment of various size clamps and flanges, to take all sizes of ship connections, in addition to wrenches, ropes and odd equipment. The loading hose may be kept on the dock stretched out ready for use. The size of hose is governed by pumping capacity, but rarely exceeds eight in. in diameter. This is what is known as suction and discharge type, and is reinforced with steel or aluminium spirals on the inside. For moving it around the dock several strong dollies on castors are needed.

# • Article I •
# Docks, Firewalls and Tankage

By M. C. COCKSHOTT
Design and Consulting Engineer



Unusually large freighter loading at docks of Monarch Refineries, Long Beach, Calif.

The design of the dock should conform with local port requirements, as well as the needs of the commodities to be handled. The piling should be creosoted, with all members that come in contact with the water also creosoted for a 12-lb. treatment, and brace piling should be used at each bent securely ironed to the vertical piles. Where the piles are capped, the pile top is treated with creosote and felt, and the cap dowelled in place. The bull rail is raised off the decking and provision made for draining all water off the dock. At the corners of the dock several piles are driven to take care of the blow often inflicted by a ship when docking. It is often necessary to replace these, as they get broken with repeated blows. Along the sides of the dock, and between the bents of piling, some ports require fender piles; these are short stubs that are secured to the dock, and extend below low water, and not driven into the bottom. A fender log is chained to them, so that it rises and falls with the tide, holds the ship off, and prevents direct contact with, the dock. However, some authorities do not advocate this as they assert the log often jams in between the piling and breaks the latter off. It goes without saying that there must always be a sufficient depth of water to take care of the largest tankers. The dock is usually built out to the Pier Head Line, a location set by the harbor authorities, who take care of the water depth outside of this line, and if for any reason the dock front is short of this mark it is up to the dock owner to dredge out up to the Pier Head Line.

A dock should be equipped with a life buoy and hand line at least 200 ft. long, also a small skiff is at times very useful in assisting to moor a ship when there is a wind or other conditions that make it difficult to get a line ashore.

Next to consider are the tankage and firewall. It is hardly within the province of this article to give more than a cursory idea of the general designs employed at this part of the terminal. Tanks may be of riveted or of welded construction. The latter type is coming to the fore very rapidly. The Monarch Oil Company of Los Angeles has lately installed four 15,000-bbl. welded tanks with great success. Where gasoline is carried a floating roof tends to keep down vapor losses; in any case, water-sealed roofs are recommended if there is likely to be any considerable amount of heat from the sun. Where land is at a premium some space may be saved by raising the height of the tanks and thus cutting down the diameter.

Foundations must be designed to suit the local soil conditions, and where they are to be built on made-up ground, considerable care will have to be taken so that the settlement is evenly distributed; the cost is high, but is money well spent, as a poor tank foundation is costly to repair or maintain.

In most areas it is imperative that the tanks be enclosed in a firewall to protect the surrounding country in case of tank failure caused by fire or other means. Usually the capacity of the space inside the wall is one and one-quarter that of the tank capacity in order to provide for boiling over in case of fire. The walls are of different types, usually of the cantilever reinforced concrete type; however, in country areas an earthen type of wall is used. This is laid so that the soil is on a one to one slope, and often has a concrete apron on the inside, though the exact need of this is not quite apparent. The Hancock Oil Company at its San Pedro terminal has a rather peculiar type of wall known as the Aston Stepwall type, the cost of which compared very favorably with the cantilever type. Any sort of concrete wall that is used must be provided with expansion joints at intervals, and it is good practice to lay an extra pipe or so through the wall to take care of any future extensions.

Tanks must be equipped with vents of the proper size to take care of the breathing caused by filling and emptying. These vents are usually fitted with an approved type of flame arrester. In large tankage a vapor recovery system is used to advantage, but in the average marine terminal this is not needed as the tanks are rarely kept filled for any length of time. All fittings inside the firewall are usually of steel, as are the valves. The valves on the suction lines to the pump house are often doubled, so that in case of a leak there will not be a loss of oil. In placing these valves a welded or riveted flange is attached to the tank, and a short spool welded to it, and for gasoline especially, the use of threads is deprecated, as they invariably give trouble, hence welding throughout is advocated. In the gasoline tanks, most oil companies favor the use of the lubricated type of plug cock. The suction lines usually enter the tank at about 12 in. from the tank floor, and should have a swing pipe on the inside, whereby the product can be taken from any part of the tank, and so the tank can be practically emptied of gasoline. To provide for the final emptying, all tanks should have a drain at the lowest part, usually near the center, in fact a small sump hole is sometimes built into the tank floor. The drain from the black oil tanks will run by gravity to the sump tank, a steam connection is tied in so that in cold weather the line may be cleared if it becomes stopped up.

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*Editor's Note*—This is the first of a series of two articles on the design of marine oil terminals by M. C. Cockshott. The second article of the series will appear in an early issue.

# Manufacture of Special Products from Crude Distillation Unit

By
T. B. LEECH
Refinery
Engineer

**Addition of auxiliary fractionating equipment of proper capacity may suffice for requirements**

IN a previous article the relative efficiency of various methods of fractionation was discussed. It is assumed in this article that the pipe-still single-flash method of distillation is employed. This presupposes that a main tower with sufficient plates to produce a 250-deg. fahr. end point gasoline, together with side strippers sufficient in number to produce a naphtha, kerosene, and gas oil cuts with boiling ranges controllable down to 125 deg. fahr. has been installed.

A great many modern refineries, having crude units similar to this processing up to 15,000 bbl. per day of crude, wish to produce small quantities of various special products, such as petroleum ether, aviation gasoline, rubber solvents, turpentine substitutes, cleaning fluids, absorption oil, special long time burning oils, and special domestic heating or Diesel fuels. Installation of special equipment for this purpose is expensive. Inasmuch as specifications on the special products frequently vary with individual purchasers, and as the orders for such materials are generally small, it is inadvisable to upset the main distillation unit by attempting to make such products, even if it were possible on such units.

The installation of special shell still and tower equipment to manufacture special by-products, together with the necessary maintenance and operating costs of such equipment, militates against the success of going into specialty manufacture on this basis. The majority of the specialties that can be made by primary distillation of crude or light distillates, can be made by pipe-still tower fractionation. It is only necessary to add certain auxiliary fractionating equipment, of the proper size to produce the required amounts of distillates, to the main fractionating system to be able to produce simultaneously, aside from the ordinary refinery distillates of low end point gasoline, reforming naphtha, kerosene, and gas oil, several by-products. A great number may be produced successively, and a limited number simultaneously. Fig. 1 represents the main fractionating equipment before the addition of the specialty equipment.

If there is being produced from the unit illustrated a gasoline of 250-deg. fahr. end point and a reforming naphtha of 250-deg. fahr. initial and 400-deg. fahr. end point, and at the same time it is desired to produce successively an aviation gasoline, or a rubber solvent, and a petroleum ether, Fig. 2 shows the additional equipment that will be needed.

Rubber solvents as a rule must be over 105-deg. fahr. initial and under 300-deg. fahr. end point, with various specifications for intermediate points. Aviation gasoline may be desired with various intermediate boiling points, an initial of approximately 110 deg. fahr. and an end point of 325 to 340 deg. fahr., depending on grade and purchaser. Petroleum ether is 140-deg. fahr. initial and 176-deg. fahr. end point, with certain variations, due to market demand.

The 250-deg. fahr. end point gasoline from the main fractionating tower would have an initial of from 90 to 100 deg. fahr., depending on refinery efficiency, and the condition and kind of crude being run. In order to produce aviation gasoline and rubber solvent, this initial must be raised without permitting any heavier constituents to escape, or the lower distillation percentages of the resultant products will be too high.

Without disturbing the operation of the main tower or the side strippers, certain definite proportions of the overhead gasoline, plus top side stream, either before or after stripping, mixed together, should be fed through heat exchangers to the refractionation tower at the correct temperature to effect the desired fractionation. All the ultimate overhead from the refractionation tower, plus the aviation gasoline or rubber solvent, should be vaporized before entering the refractionation column or it must be vaporized in the column. The feed to the refractionation unit enters the lower section of the column. Heavy material is drawn from the bottom. Vapors of the desired end point ascend the vapor by-pass into the upper section of the column. In this section of the refractionator the final product is brought to correct initial and is withdrawn from the bottom of the section. Top reflux with correct instrument control assures a product of proper specifications. Reflux for the bottom section of the refractionator is provided by gravity flow of the finished product through a correctly designed temperature controller.

In view of the extremely light material coming overhead as vapor from the top of the tower it is desirable that the refractionator be designed to operate under pressure sufficient to condense reflux for the particular product being made. Aside from the connections necessary for the above operation, it is further desirable that the refractionator be piped so that each section can be used as a secondary stripper, thus permitting under certain conditions of proper feed, the manufacture of two distinct products from two different feeds in this piece of apparatus.

When making petroleum ether with boiling points specified above, or even of other boiling ranges just so they fall within the limits of the overhead gasoline, the same tower can be utilized in the exact manner described for manufacture of aviation gasoline, except that nothing save a portion of the overhead gasoline stream need be fed to the refractionator.

With the main fractionating column top side stripper producing a 250-deg. fahr. initial boiling point, 400-deg. fahr. end point reforming naphtha, the production of the usual cleaner's naphtha is simple. If the refiner wishes to continue to produce the reforming naphtha, and at the same time pro-

duce a 300-deg. fahr. initial 400-deg. fahr. end point cleaning naphtha, the product from the top side stripper can be fed into a simple secondary stripping column, as indicated in Fig. 3. If preferable, this column need not be fed through the exchanger but in any event should have a reboiler. This latter minimizes the amount of steam ultimately returning to the main tower. It need not be refluxed as the feed provides reflux for the column. The overhead from this secondary stripper should return to the primary at a point that will least disturb the equilibrium of the latter, or if desirable, the overhead may be separately condensed as another special product. The bottom product from the secondary stripper should be of the required specifications.

Distillation ranges of some of the typical turpentine substitutes follow:

| Column | No. 1 | No. 2 | No. 3 | No. 4 |
|---|---|---|---|---|
| Initial - - - | 230 | 288 | 310 | 305 |
| End Point - - | 460 | 412 | 364 | 350 |

There are many other ranges specified by different purchasers, all with individual specifications as to intermediates.

The turpentine substitute in Column No. 1, while having much the broadest boiling range, is perhaps the most difficult to make under the fractionation set-up under discussion. Most of this product would come from the top primary stripper with its range of 250 to 400 deg. fahrenheit. A small amount of light material below this range is present in the material withdrawn from the main column to the side stripper. As not over five per cent of the particular turpentine substitute under discussion is permitted to distill at 266 deg. fahr., it is obvious that the correct initial is contained in the product withdrawn from the main column as the top side stream.

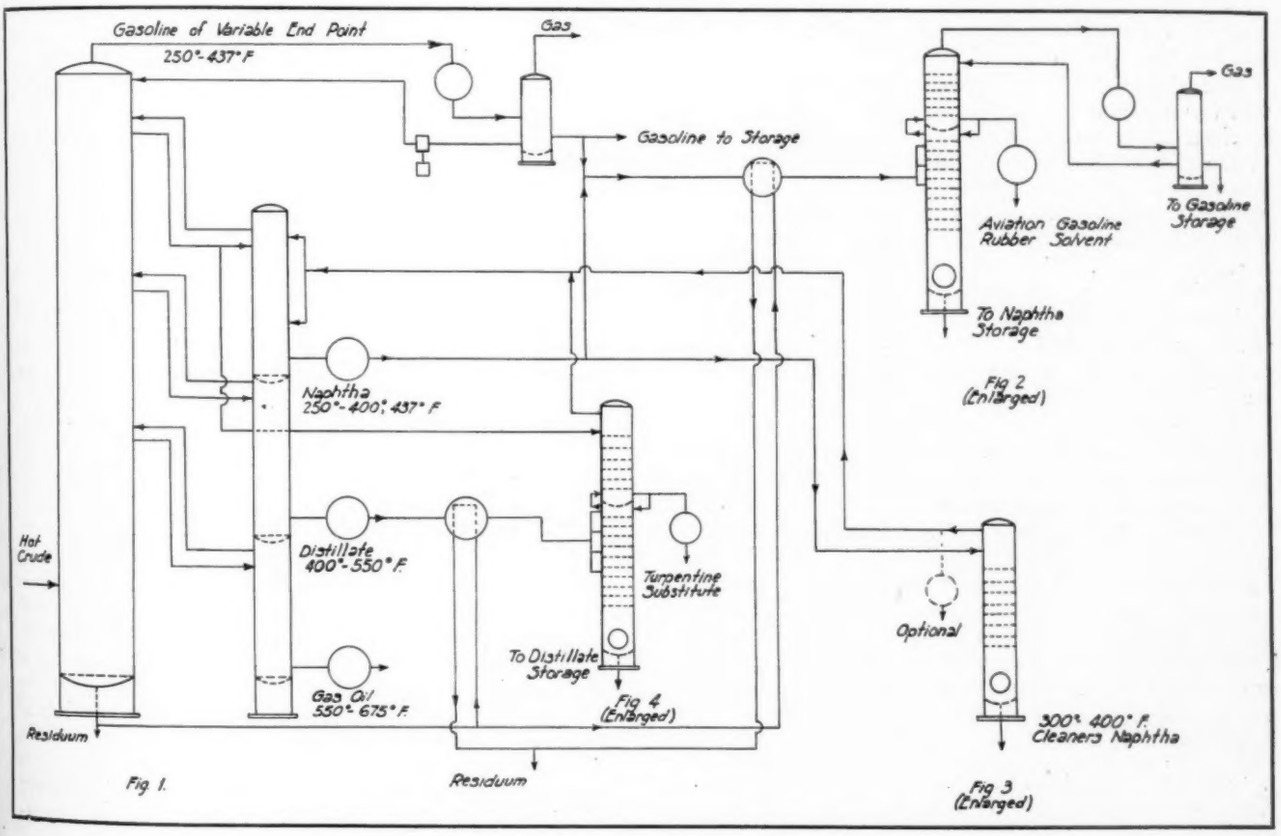
In order to procure the exact turpentine substitute desired, draw this material from the main tower into a secondary refractionator built identically with the one shown in Fig. 2. In this case, however, feed the column at the top, using the upper section purely as a stripper. This is illustrated in Fig. 4. Into the lower section of the column there should be fed a small quantity of the 400 to 550-deg. fahr. end point distillate. This should be fed through a heat exchanger and partially vaporized. The bottom product will go to distillate storage after reboiling, the vapors from the bottom section of the secondary by-pass the separator plate between sections and completes the finished product, which is drawn from the upper section of the refractionator. Reflux to insure proper end point is obtained as with the aviation gasoline or rubber solvent and as illustrated.

It will be noted that turpentine substitute listed in Columns No. 3 and No. 4 are both within the range of the reforming naphtha side stream. Nevertheless, both a top and bottom cut must be made from this side stream in order to obtain the exact specification required on the turpentine substitute. This is also best done in a two-section fractionator, using only a single feed from the reforming naphtha side stripper to the refractionator as shown in Fig. 2.

In certain refineries, particularly those operating on specific Michigan and Kansas crudes, it may be desirable to remove very short cuts from the reforming naphtha, this short cut only to be reformed, thus obviating the necessity of reforming the total of the large percentage between 250 and 400 deg. fahrenheit.

When advantage is taken of the fact that all characteristics of the streams from the main fractionating column and side strippers, except the initial of the overhead from the main column, can be changed as desired, it will be seen that the method illustrated above will serve for the production of any special crude distillate that may be desired as a special product. Instead of building secondary stripping towers, it appears that all secondary auxiliary towers should be of the two-section refractionating type. This construction will permit much greater diversification of special products manufactured either simultaneously or successively than would several secondary strippers.

**Figs. 1, 2 and 3**



# Shooting In the Ritz-Canton Field,

By VAN D. BENNETT
Engineer, Derby Oil & Refining Co.

A SURVEY of shooting practices and a study of the methods of using explosives in oil wells in the Viola limestone area of the Ritz-Canton field, McPherson County, Kansas, reveals some interesting practices in shooting procedure, each of which is supported or justified by some theoretical or factual proof of its merits. In shooting an oil well the chief objective is to obtain economically the greatest possible increase in daily rate of oil production without incurring any undue sacrifice in ultimate recovery. One of the important things to guard against is the possibility of damage to the casing or casing seat. Simple as the shooting of a well may seem, it is surprising to find the wide diversity of opinion that exists among operators concerning the procedure to be followed to obtain the best results.

There are three main theories advanced by oil producers and explosives engineers concerning what happens in the bottom of the hole when an oil well is shot. First, the shock of the explosive sets up vibratory waves of disruptive intensity that tend to break down the strata, thus opening innumerable avenues of escape for the oil; second, the gases evolved by the explosion in rushing up out of the hole cause a partial vacuum, which draws oil from the oil-bearing horizon; and, third, the shock of the explosion with the resulting vibrations starts effervescence of the gas-charged oil. It is probable that all three theories explain and have a bearing on what actually happens; the first being the immediate result, and the other two the after-effects.

Nitroglycerin, when completely and properly exploded, is transformed from its inert, liquid or solid state, into energy by chemical reaction, with the evolution of heat, whereby the combined substances of which it is composed are converted into carbon dioxide, water, nitrogen, oxygen, etc. The explosive is converted into a gaseous state with such terrific speed and at such a high temperature that it develops great disruptive energy. This is communicated to the surrounding material in vibratory waves of great initial intensity though with rapidly diminishing effect. The extent of the disruptive effect is controlled by the type and quantity of the explosive used, the degree of confinement, and the character of the material surrounding it.

It is quite reasonable to assume that the largest increase in oil production should be expected from the shot that produces the greatest degree of breakage or fragmentation. The factors that determine the degree of breakage or fragmentation and should be carefully studied by the operator before shooting are: The type of explosive; the nature and resistance of the material to be broken; the quantity of explosive; the degree of confinement; the type and quantity of tamping or stemming; and the placing of the shot with respect to the saturated zone. These are factors regarding which wide diversity of opinion exists among oil operators and production engineers in connection with oil well shooting practice. Each is therefore discussed separately in the following paragraphs.

**Type of Explosive.** Oil well explosives are of three distinct types, namely, liquid nitroglycerin, solidified nitroglycerin, and gelatin dynamite. Of these only the first two will be considered, since gelatin dynamite is seldom if ever used in the limestone area under discussion.

Liquid nitroglycerin has an inherent excess of oxygen and therefore explodes uniformly with a maximum velocity and strength. It is only slightly affected by hydrostatic pressure and always delivers a blow of the same force per unit of volume, regardless of the nature of the material being blasted. At the moment of explosion, one lb. of liquid nitroglycerin yields 157.7 cu. ft. of gases at the rate of 23,600 ft. per sec., the temperature is raised to 6280 deg. fahr., the energy produced is equal to 2,200,000 ft. lb., and, depending upon the size of the cavity and the degree of confinement, the pressure developed is approximately 145,900 lb. per sq. inch.

Solidified nitroglycerin is made by dissolving just enough collodion gun cotton in liquid nitroglycerin to cause the liquid to gelatinize and form a plastic, somewhat spongy solid. Both of the ingredients are among the most dangerously sensitive explosives known, yet the mixture forms a relatively safe commercial product. On being detonated, one lb. of solidified nitroglycerin yields 170 cu. ft. of gases at a rate of from 8000 to 23,600 ft. per sec., the rate depending upon the degree of compression. The temperature, which is proportional to the rate of detonation, is raised to 6400 deg. fahr., the energy produced is equal to 2,300,000 ft. lb., and the pressure, depending on the degree of confinement, is approximately 156,000 lb. per sq. inch. If exploded under atmospheric pressure, solidified has the same rate of detonation as liquid nitroglycerin, but when compressed, the rate of detonation of solidified nitroglycerin is lowered as the compression on the shot is increased. The exact ratio of the pressure on the shot to the rate of detonation is not known, but it has been definitely proved that superimposing hydrostatic head on the solidified shot will give a variable rate of detonation ranging from 8000 to 23,600 ft. per second.

In blasting practice it has been proved that when a crevicing or widespread shattering effect is desired, an explosive with a low rate of detonation should be used, and that when a local shattering effect is desired, an explosive with a high rate of detonation is preferable. Applying this to oil-well shooting practice, the question arises regarding what effect is desired from an explosive in the saturated zone of the strata being shot. A majority of the operators in this area are inclined to believe in the efficacy of crevicing or widespread shattering and therefore use solidified nitroglycerin. Others, however, evidently desire intense local shattering of the pay formation and consequently use the higher-frequency liquid nitroglycerin.

There are other factors that govern the choice of the type of explosive. The relative safety of solidified nitroglycerin compared with that of liquid nitroglycerin is generally recognized and statistics prove that premature explosions result almost entirely from the use of the liquid explosive. It also seems that a certain amount of prejudice against the use of the solidified product still persists among some operators, who, in by-gone years, when the use of solidified nitroglycerin was comparatively new, had to fish out, or had blown from the hole unexploded, partially unexploded, or partially burned and partially unexploded shells of the solidified product. In this connection it should be remembered that solidified nitroglycerin was not primarily manufactured for use in shooting wells, but was first introduced because of safety in transpor-

# Practices McPherson County, Kansas

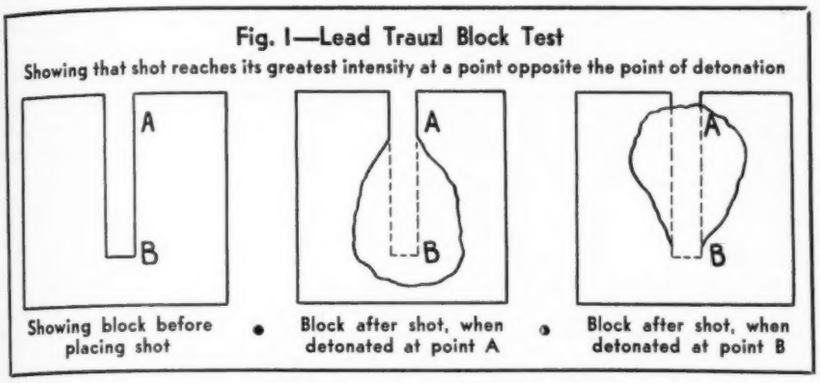



**Fig. 1—Lead Trauzl Block Test**

Showing that shot reaches its greatest intensity at a point opposite the point of detonation

Showing block before placing shot • Block after shot, when detonated at point A • Block after shot, when detonated at point B

tation. It was not until about three years ago that it was sensitized to a high degree, thus making it a highly dependable oil-well explosive. If solidified nitroglycerin is procured from a reliable glycerin company there need be no concern over the probability of incomplete detonation. Some operators, recognizing the soundness of the theory of the local action of liquid nitroglycerin and of the more general disruptive effect of the solidified product, use the liquid form when the shot is to be set within a few feet of the shoe of the casing. Their belief is that liquid nitroglycerin, because of its local shattering effect, is less likely to damage the casing or casing seat than the solidified product. It is doubtful, however, whether in this connection any distinction between the two types should be drawn, since proper tamping probably is the greatest controlling factor in eliminating the possibility of damage to the casing or the casing seat. In choosing the type of explosive to give the best result, it should be remembered that a primer, or initiating detonator, of sufficient strength is essential to proper detonation of the shot. Proper detonation results in the complete disintegration of the molecules of the explosive and no doubt has much to do with the effectiveness of the resultant explosion. In the past, many shooting failures have undoubtedly been caused by the inefficient detonation of the shot because a weak detonating agent was employed. The use of the go-devil, jack squib, and bumper squib has been practically discontinued in the area herein discussed. Double-action mechanically-operated time bombs and electric time bombs, enclosed in cast-iron shells capable of withstanding a high hydrostatic pressure, are in general use. There is no record of detonation failure in this area where the bomb type of detonator has been used.

About 60 per cent of the wells shot in the Ritz-Canton field were shot with solidified nitroglycerin and 40 per cent with liquid nitroglycerin. Solidified nitroglycerin seems to be gaining in popularity because of the fact that its action is to some degree controllable and because of its relative safety.

**Character of Formation.** The saturated zone of lime or sand to be shot will of course vary greatly in each field and usually from well to well in a specific producing stratum. However, the general characteristics of the producing horizon are usually known and a careful study of the individual well log will assist in determining the particular type of formation to be dealt with. If a rotary-drilled well, it is probable that the producing formation has been cored; and an examination of the cores should indicate the porosity, permeability, and texture. If the well was drilled in with cable-tools it is generally a comparatively simple matter to obtain the same information from an examination of cuttings recovered at frequent intervals in the bailer.

The Viola formation of the Ritz-Canton field may be described as a coarsely crystalline, grey-white limestone. It is dolomitic in places, the degree of dolomitization determining the porosity. Although they vary greatly in different wells, both the porosity and the permeability are considered high for the Viola limestone. As the productive part of the lime when drilled ranged from hard to very soft and was so logged, the degree of hardness or softness has served in many cases as a guide to the quantity of explosive used.

**Quantity of Explosive.** The quantity of explosive used is dependent upon the diameter of the hole, the thickness and character of the productive saturated strata, the condition of the hole, the degree of confinement desired, and the disposition of the operator to shoot below the top or bottom (or both) of the saturated strata. Generally, the more resistant oil-bearing rocks, such as hard limestones and sandstones, are effectively shattered by reasonably heavy shooting, whereas in the softer limestone and sandstones, best results are obtained by shooting with much lighter shots. As a rule the more or less unconsolidated and soft sandstones are shot with light shots because heavy shooting may compact them and thus retard, rather than increase, production.

Since the thickness of the saturated zone in the Viola limestone in this area averages only four to five feet, and the diameter of the hole is usually five in., or smaller, there is a physical limitation on the size of the shot that must be used. As the productive part of the lime varies from hard to very soft the amount of nitroglycerin used per well was from 5 to 30 quarts. In at least one instance, where moderation in shooting enforced by necessity as well as judgment, shooting in the narrow strip of limestone has resulted in unusual increases in production. The average size of shot used was ten quarts and most operators agree that, generally speaking, the 10-quart shots were the most effective. This is probably the only point involved in the shooting of wells in this area on which operators are in almost unanimous agreement.

**The Degree of Confinement.** The degree of confinement probably influences the efficiency of a shot more than any other one factor. Some operators select the shell of largest diameter that safely can be run into the hole when a heavy shot is desired; others use shells of smaller diameter and of various sizes. In this area the shells used range in diameter from two in. to four inches. If the hole is in good condition it is not unusual to run a shell one inch smaller in diameter than the diameter of the hole, thus allowing a clearance of only one-half inch, assuming that the shell is run concentric with the center of the hole.

When completing wells in the Viola formation it is customary to drill from two to six ft. beyond the saturated zone in an effort to pick up a lower streak of porous lime that might increase the production of the well. Since this streak is seldom found, the barren hole drilled below the saturated zone necessitates the use of some type of anchor for the shot. The anchor most widely used is the so-called dry anchor, consisting of an empty tin container, sometimes con-

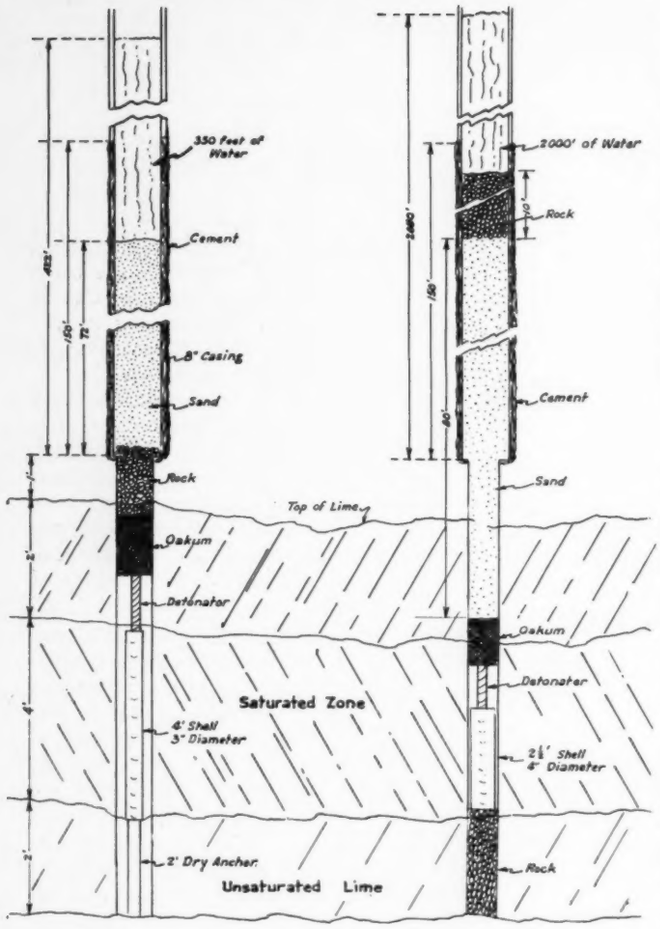



Fig. 2




Fig. 3

structed specially for this purpose. Another type of anchor in use consists of rolled galvanized tin and broken rock, or broken rock alone.

Good engineering practice would seem to dictate that the most effective anchor consists of small pieces of broken rock or brick dropped into the hole and heavily tamped with the tools. This provides a solid anchor for the shot and precludes the possibility of energy from the shot being dissipated below the saturated zone. It can be proved by test (Fig. 1) that the effect of the shot reaches its maximum intensity directly opposite the point of detonation. That being the case, the use of a dry anchor results in a dissipation of explosive energy below the objective, whereas the rock anchor tends to confine the explosive energy in the saturated zone.

Affecting the degree of confinement of a shot, tamping above the shot is one factor that has come in for much discussion.

**Type and Quantity of Tamping or Stemming.** The type and quantity of tamping used above the shot is of great importance not only in confining the explosive energy in the saturated zone of the pay, but also in eliminating as far as possible, any damage to the cap-rock, the casing or the casing seat. There are three types of tamping used, namely: liquid tamping, solid tamping, and a combination of liquid and solid tamping. Each of these three types may be modified to produce almost any conceivable degree or type of tamping desired.

Fluid (liquid) tamping has long been practiced in the shooting of oil and gas wells. Prevailing ideas on the efficiency of fluid tamping are based on the theory that because of the high rate of detonation of oil well explosives, it is necessary only to create a condition of air-tight confinement to cause complete detonation and that such detonation must do its work before there is any considerable loss of pressure by the upward movement of the fluid column. In contradiction to this theory on the efficiency of fluid stemming the following assertions are made: A unit quantity of liquid or solidified nitroglycerin produces at the moment of explosion more than 700 times its own volume of gases that are stable at normal temperatures, but because of the extremely high temperature at the moment of explosion these gases are greatly expanded and tend to occupy a much larger space. But one pound of either explosive develops pressure and energy of such vast proportions that it is quite apparent that a fluid (liquid) column, with only its gravity and frictional resistance, is insufficient to hold the resulting pressure and that the fluid must move up the hole at high velocity, thus using up part of the explosive energy.

Numerous tests made by the United States Bureau of Mines, explosives manufacturers, and quarry operators, indicate that solid tamping or stemming of one kind or another, properly applied, is the most effective in producing the desired results. Damp sand is frequently used as a form of solid tamping and when it is properly placed and applied in sufficient quantity it forms a relatively immovable bridge in the hole, and should produce the greatest degree of confinement. Considerable data[1] collected from several fields, on the results obtained by shooting where sand tamping was used point to the effectiveness of this type of tamping.

Although this type of tamp is the most effective in positively confining the gases of the explosion to doing useful work, a tamping consisting of solid material alone is rarely possible in shooting an oil well that is making any quantity of fluid. However, comparative records, collected over a wide area, of production increases from wells that were shot, tend to emphasize the value of using sand and other forms of solid tamping, regardless of whether the sand was used alone or in combination with fluid tamping. It is reasonable to assume when fluid tamping is used that the great upward velocity or rate of travel of fluid and the heated disruptive gases up the hole produce a disruptive effect of sufficient intensity seriously to disturb or possibly break down the walls of the hole above the pay, with resultant expensive cleaning out and possible damage to the casing or casing seat.[2]

Practically all the wells in the Ritz-Canton area are finished with the oil string cemented. In some wells the casing has been set and cemented on top of the Viola limestone. As the saturated zone is found only two or three feet below the top several delicate shooting problems were encountered, nevertheless, several wells are known to have been shot within three feet of the casing seat with no apparent damage. A combination of oakum, rock and sand was used for tamping in these cases. Where the pipe is cemented some distance above the top of the lime, trouble is sometimes encountered after a shot with caving from the grey-green, Kinderhook shale and/or the black Chattanooga shale overlying the Viola lime. Comparative data are not available on the type of tamping used in those wells that caused the greatest amount of trouble in this respect, but it would seem that proper sand tamping should tend to lessen the danger of damage to the overlying formation.

All solid tamping done in this area should really be considered as a combination of solid and liquid tamping, for the rising column of live oil extended up into the casing despite efforts made to keep it swabbed down, and hence liquid in varying amounts was used as tamping for the shot. Opinion differs among proponents of solid tamping regarding the arrangement of the solid materials and the amount of fluid that should be placed above the solid material. The general ar-

[1] "The Effect of Sand Tamping on the Efficiency of Explosives in Oil-Well Shooting," by Paul F. Lewis, American Glycerin Company.

[2] See illustration, p. 27, *The Petroleum Engineer*, March, 1933.

rangement used by several operators in tamping their shots is as follows:

Either some burlap weighted down with sash weights and dropped into the hole or a container of oakum from 2½ to 5 ft. in length is placed immediately above the detonator. When oakum is used it is placed in containers of as large a diameter as can safely be run into the hole and placed just above the shot, after which it is carefully tamped with the tools to flatten it out to the full diameter of the hole. The burlap or oakum serves to keep the sand from falling down around the shell, thus obviating the possibility of creating too great a degree of confinement. To weight down the oakum or burlap and prevent the rising column of fluid from displacing it, one or two containers of rock three or four inches in diameter and about 2½ ft. long are then run and carefully tamped. When properly placed the rock has a friction hold on the sides of the hole and thus assists in holding down the force of the explosion. When most of the shooting was done the average fluid level in the field was about 2000 feet. If there was a greater column of fluid than desired, the well, after setting the rock container, was swabbed until within a half hour of the time for the shot to explode; after pulling the swab the last time, about one cu. yd. of sand was shoveled into the hole.

In Figs. 2 and 3 are shown two methods of placing the shots where oakum, sand, rock and fluid were used. The casing was cemented approximately one foot above the top of the Viola lime in this case. The method illustrated in Fig. 3 is considered by explosives engineers the more scientific arrangement and the one that should result in the more effective shooting of the well. As an added precaution to protect the casing some operators attempt to swab the fluid down so that when the explosion occurs the top of the fluid level will be below the top of the cement behind the oil string. In most cases this was impossible and fluid was allowed to remain on top of the tamped sand at various levels ranging from 350 to 2000 feet. Since the fluid causes the sand tamping to lose some of its efficiency, it is believed that the entire 2000 ft. of fluid is more effective than trying to lower the fluid level to any certain point. This assumes, of course, that the fluid is all oil or all water and not both, which would involve danger to pipe at the point of oil-water contact.

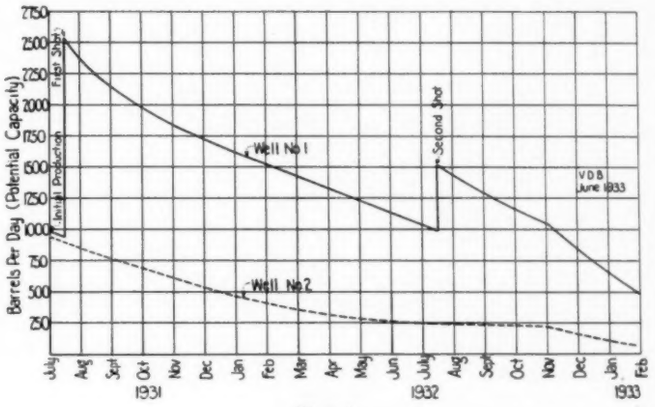



Fig. 4

**Placing the Shot with Respect to the Saturated Zone.** Although the average thickness of the saturated zone to be shot is about four ft., practice in placing the shell with respect to this zone is not uniform. Some operators place a 4-ft. shell flush with the top and the bottom of the zone; others use a 6-ft. shell, with the bottom of the shell extending two ft. below the bottom of the zone, and still others use a 4-ft. shell, the top of which is placed two ft. below the top of the zone with the bottom of the shell extending two ft. below the bottom of the zone. It is known that the disruptive effect of a shot extends in a general direction of 45 deg. upward, hence it is believed that a 2-ft. shell of as large a diameter as can safely be run, placed two ft. below the top of the zone and flush with the bottom would produce the greatest disruptive effect on the saturated zone.

Notwithstanding the fact that opinion differed greatly upon practically all the factors involved in the mechanics of shooting, and that many different shooting procedures were employed, the average increase obtained throughout the entire area was fairly high, it being estimated at 85 per cent. Several edge wells that produced an average of 250 bbl. a day upon completion were increased to 1500 bbl. a day by shooting.

There are a few cases where shooting seemed to decrease rather than increase production. The theory that in these wells the face of the lime was burned can be disproved, for in the fractional part of a second in which the intense heat is generated and dispelled, the lime itself could not possibly be affected. There are, however, two theories in this connection that are accepted and are worthy of consideration.

In some wells in which shooting resulted in a decrease of production small particles of lime were fished out of the hole that were coated with a black shiny substance. Chemical analysis of this substance showed it to be a deposit of carbon, and it is commonly referred to in this sense as carbonized oil. The lime itself was found to be unaffected in any way. It is believed that this condition is caused by the explosive being burned or partially burned instead of being exploded. Manufacturers of explosives believe that the use of a solidified shell of very small diameter, where the compression is very great, tends to produce incomplete detonation or partial burning of the shot, although the reason for burning of a shot is generally erroneously attributed in the field to the use of improperly manufactured nitroglycerin.

Glycerin trinitrate or nitroglycerin in the commercially pure state, having the required nitrogen content, will in all cases where properly exploded, detonate completely without burning. Nitroglycerin improperly manufactured may contain certain impurities, such as the impurities resulting from the action of acid on nitroglycerin in storage, where the presence of such acid is due to improper washing and neutralization and perhaps improper storage, or impurities such as mononitro or dinitro-glycerin or both, resulting from rapid nitration at high temperature and/or improper balance of oil and acids before nitration.

Where a nitroglycerin containing a relatively high percentage of impurities is used, it may be difficult to explode by the conventional oil field methods or devices so as to obtain complete detonation. In such cases it is highly probable that all or part of the nitroglycerin charge will burn at high temperature. It is believed that this burning effect will cause the deposit of carbonized oil on the face of the lime. Operators should therefore assure themselves that the product they use is made by reliable nitroglycerin manufacturers who have ample facilities for testing their product.

It is also reasonable to assume that where sludge or small particles of materials are allowed to collect around the outside of a shot that this sludge or small particles may smear the face of the porous strata or be forced into the pores in such a manner as to decrease production. Where the lime is very soft, it is not believed to be good practice to shoot with any but small shots because of the possibility of the lime being plastic enough to be smeared by the shot.

**"Lodestone" or Local Magnetic Fields.** While running a shot in one well in this area the shell unhooked at about 750 ft. below the surface and dropped to bottom, so it was decided to conduct tests on this well to determine what caused the shell to unhook from the shooter's line and in particular to prove or disprove the possible existence of local magnetic fields. A regular tin-coated shell filled with sand until it

. . . *Continued on page 26*

# Toledo-Detroit Gasoline Line Completed

By WARREN L. BAKER

CONSTRUCTION and testing of a gasoline pipe line from Toledo to Detroit has just been completed. This new 6-in. gasoline carrier will transport motor fuel from the refineries of the Pure Oil Company and the Sun Oil Company at Toledo, Ohio, to Detroit, Mich., a distance of 80 miles. It has been equipped with two pump stations, one at the Pure's Toledo refinery and the other at the Sun's refinery. The terminal at Hamtramck, on the outskirts of Detroit, is practically completed, and within the next few days, the Nation's latest gasoline pipeline transportation system should be in full operation. Construction was started by the contractors, Ford, Bacon & Davis, on April 15, and finished on July 15. Five weeks of rain delayed the work to a large extent, and in addition, several unusual conditions of construction entered into the work that tended to retard progress.

Beginning the double 6 in. Maumee River crossing near Toledo

This line lays claim to several distinctions. It has been constructed on one of the narrowest pipe-line right-of-ways in existence. The route of the line directly parallels the main Toledo-Detroit highway and the right-of-way, only 8 ft. wide, was alongside the paved road. The line has more tunnels than any other line of equal length, and probably more than many lines of much greater length. In addition to crossing many highways and railroads that necessitated tunneling operations, the construction contract stipulated that all trees be carefully handled and that no root of more than one inch or larger in diameter should be cut. This stipulation, together with the narrow right-of-way, made it necessary for the contractors to tunnel beneath many trees, as clearing of the right-of-way was virtually prohibited.

Because of the large number of tunnels to be dug a special boring machine was used for this purpose. This machine carried the casing, pulled it through the tunnel, and drilled the hole all in one operation. It proved to be very accurate and on the longest bores, when properly adjusted, did not vary from the desired termination more than one inch. A system of levels and guides were the chief factors in aligning the machine and in keeping it to its course.

Although several creeks were crossed, only one major river crossing, the Maumee River, was necessary. The pipe was welded by the Linde process into long lengths and these were placed on the river bottom by means of a barge. Several piles were driven to locate and anchor the double 6-in. line near the river bank. River clamps were employed in lining up the pipe for tie-in wells on the barge.

W. B. Winters of the Pure Oil Company pipe line department was in direct charge of all field work and H. A. B. Prindle was construction superintendent for Ford, Bacon & Davis.

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*Continued from page 25 . . .*

equalled the weight of the nitroglycerin shell that had unhooked was carefully run into the hole. The shell hung up at three distinct levels, one of which was 750 ft., the point where the first shell became disengaged. A copper shell, weighted similarly, was then run into the hole and a careful observation showed that there was no tendency for the copper shell to hang up or stick at any point. This experiment proved to the satisfaction of the operator that the dropping of the shell was caused by local magnetic attraction and not by any obstruction or rough places inside the casing. The use of a special insulated shell, provided by nitroglycerin companies at no extra expense to the operator, and careful lowering of the explosive on the shooting line will greatly reduce the hazard of dropping the shell and its consequent premature explosion.

The curves shown in Fig. 4 give a rough comparison of two wells in the Ritz-Canton area, one of which was shot twice and the other has never been shot. Each well on completion had about the same initial production. Although the curve on Well No. 1 is not necessarily a typical curve for wells in this area that are shot, it would appear from the increase in production obtained that the shooting of the well was justified.

### Conclusion

It is concluded that oil-well shooting procedure in the Ritz-Canton field, Kansas, has generally been determined by precedent rather than by a proper consideration of the engineering factors involved in the correct use of explosives. Shooting an oil well is a problem calling for highly specialized knowledge and experience, hence the many factors that enter should be considered in detail preparatory to placing the shot in order to obtain the best results.

Acknowledgment is made to Paul F. Lewis, American Glycerin Company, for assistance in the preparation of this article; to T. J. Hamilton, Phillips Petroleum Company; Forrest Broadwater, Lario Oil and Gas Company; Frank Zimmerman, W. C. McBride, Inc., and Bobbie Burns, National Torpedo Company, for assistance in the completion of field data, and to A. S. Ritchie, Derby Oil Company, and D. H. Sholtus, Shell Petroleum Corporation, for kindly criticizing the article.

# Cracking

## Article II. Plant Design

By W. L. NELSON

Professor of Petroleum Refining, University of Tulsa

IN Article I appearing last month, the fundamental data required in desiging cracking equipment were discussed. In this paper other factors are presented that are necessary in order to apply the bare facts given previously.

**Volume Increase During Cracking.** Although both higher and lower molecular weight hydrocarbons are produced during cracking, the major reaction is decomposition, with the overall result of producing smaller, less dense molecules. This decrease in density results in an increase in volume of such a magnitude that it cannot be neglected. In all other refinery processes the designer is safe in figuring that the volume of material entering the operation will be the same as the volume of material leaving the system if both are measured at the same temperature. Since volume changes are involved in the cracking reaction, many designers keep their calculations on a weight basis, and while this solves the problem, it is in some ways more convenient to keep the volume basis and compute the increases in volume during processing. As an example of the volume increase during cracking, consider the following weight balance, which is based on commercial yields:

EXAMPLE I. Basis: 100 gal. of cracking stock.

| *Material* | *Vol. %* | *A.P.I.* | *Lb./gal.* | *Total lb.* | |
|---|---|---|---|---|---|
| Cracking stock | 100 | 24 | 7.58 | 758 | 758 |
| Pressure distillate | 50 | 53 | 6.385 | 319.2 | |
| Cracked tar | 43 | 11 | 8.27 | 356. | |
| Liquid products | 93 | | 7.27 | 675.2 | 675.2 |
| | | | | Wt. of gas = | 82.8 |

Note that the density of the products recovered as liquids is lower than the density of the charging stock. Although the gas cannot be liquefied and measured at 60 deg. fahr., it may be dissolved in the liquid when under pressure at such points as the outlet of the pipestill heater. Since the volume of the liquid at the outlet of the still must be known in order to compute the time at the cracking temperature, it will be useful to compute a hypothetical volume for the liquefied gas at 60 deg. fahrenheit. By an inspection of the weights of slightly heavier compounds than those in the gas, the weight in lb. per gal. appears to be about three. Thus at three lb. per gal., the volume of the 82.8 lb. of gas is 27.6 gal. or the total yield of products as liquids from the cracking system is 120.6 gal., or 120.6 per cent. Thus at high pressures the volume of liquid leaving a cracking system may be about 21 per cent greater than the volume of the charge stock. Ordinarily the designer totals up the products to 100 per cent, but in this case a gross error would be involved and no end of confusion would result.

The large volume of gas obtained from all commercial cracking plants can only be explained by considering the above phenomena. Normally these plants produce enough gas to fire the cracking plant with some gas to spare. If the yield of gas is obtained by difference, that is, seven per cent, the cu. ft. of gas at 60 deg. fahr. per bbl. of stock (M. W. 32) is only:

$$[(.07 \times 42 \times 3)/32] \times 378 = 104 \text{ cu. ft. per bbl.}$$

whereas by using the correct percentage of gas the volume is 410 cu. ft. Thus for operating a 1500-bbl. plant the heat in the gas (410 cu. ft.) amounts to 35 or 40 million B.t.u. per hour, or enough to run the plant with about ten per cent to spare, while 104 cu. ft. of gas per bbl. provides only about ten million B.t.u. and far too little to supply the plant with heat.

In a few instances plant operations have been reported showing yields of pressure distillate and tar exceeding 100 per cent. In light of the above, these reports seem quite logical, since the production of even half the normal amount of gas would result in liquid yields exceeding 100 per cent. These reports appear to be reliable, particularly since some of them were for periods of operation longer than six weeks.[1]

**Volumes at Cracking Conditions.** To the designer there is no single factor of more importance than the volume of the cracking stock and the cracked products in the cracking zone. Since cracking is practiced at temperatures and pressures that approach or exceed the critical point, the computation of the volume is exceedingly complex and indeed cannot be computed exactly. Critical data are available for a few simple substances such as water, ammonia, carbon dioxide, etc., but exact data for complex mixtures such as petroleum oil cannot be found. McKee and Parker[2] and many other experimenters have found that the critical temperature of mixtures is an additive property or that the critical points of the materials constituting the mixture can be averaged. For petroleum oils the critical temperatures can be computed by a formula.[2] For reference a few critical temperatures and pressures are listed in Table I. The critical pressure for oil mixtures has not been studied completely, but doubtless it is low enough to be well below the pressures used in commercial liquid-phase equipment.

For normal gas oil and recycle cracking stocks the critical temperatures are about 900 to 915 deg. fahr. and after cracking these stocks the temperatures decrease to about 860 to 900 deg. fahr., depending upon the extent of cracking and particularly the yield of gas. Thus if a plant operates at a cracking temperature of 900 deg. fahr. and at pressures exceeding 200 lb./sq. in. the material in the cracking zone must be largely a liquid.

The computation of the exact amount of vaporization is almost impossible because our laws of equilibrium do not

[1] This is not to be confused with hydrogenation.
[2] Ind. Eng. Ch. 20:1169 (1928).

TABLE I

| Material | A.P.I. | Critical Temp. °F. | Critical Pressure lb./sq.in. |
|---|---|---|---|
| Methane | ..... | —120 | 735 |
| Ethane | ..... | 90 | 708 |
| Propane | 142 | 207.5 | 661 |
| Butane | 109 | 309 | 552 |
| Hexane | 78.9 | 455 | 435 |
| Octane | 65.0 | 565.5 | 371 |
| Decane | 56.7 | 728 | 309 |
| Dodecane | 51.8 | 760 | 191 |
| Tetradecane | 45.0 | 900 | 132 |
| Kerosene (Okl.) | 42.1 | 765 | ..... |
| "300" Oil (Tex.) | 38.1 | 851 | ..... |
| Gas oil (Pa.) | 38.2 | 892 | ..... |
| Gas oil (Cal.) | 27.8 | 858 | ..... |

hold under conditions approaching the critical. G. G. Brown's papers[3] are useful in computing the volumes of gases, if any are produced, but they can hardly be relied upon for determining the exact amount of vaporization. Since the designer is interested in getting the range of the volume if the exact volume cannot be computed, the following comparisons of volumes at the outlet of a still were made for vaporizations of 25, 50 and 100 per cent of the gas. The volume of the liquid portion was determined by the use of coefficients of expansion (or sp. gr. in the problem) and the volume of the gas by the use of Brown's[3] data.

EXAMPLE II, following Example I.

Basis: 1 bbl. of charging stock.

Outlet of still at 900 deg. fahr. and 400 lb./sq. in. pressure—25% vaporization of the gas (M.W. = 32).

lb./gal. for cracked stock (incl. 75 per cent of gas) = 737/113.7 = 6.5 (49.7 deg. A.P.I.).

Volume of P.D. and tar = .1 × 1.137 × 78/126 = 3.4 bbl.

Volume of 25% of gas (Pr = .59; Tr = 2.38; Vr = 15) = 1.67

Total volume of 1 bbl. of stock at 900° F. = 5.07 bbl.

Table II shows similar results for other vaporizations. Most authorities on equilibrium phenomena believe that little of the gas can be vaporized at these conditions. A pure compound is completely converted to vapor at its critical point, but mixtures show a range of critical temperatures. The current method[3, 4] of determining the critical temperatures of mixtures is by observing the meniscus at the critical point and indicates only the lower end of the critical temperature range. The fact to be noted from this is that the material is not an entire vapor at a few degrees above the critical point. From Table II, it is apparent that vaporizations not exceeding 50 per cent of the gas do not introduce great differences in the total volume of material.

**Recycle Ratio.** In all commercial plants the final yield of gasoline is not obtained in a single cracking operation, but by the recycling of a partially cracked stock called "Recycle." The reason for recycling is that coke is deposited and large gas losses occur if all the pressure distillate is produced in a single heating. The tarry material produced during cracking seems to be the cause of difficulties with coke. By recycling through a fractionator, the tar can be eliminated into the tar product and its concentration in the cracking stock is thus kept low.

[3]Ind. Eng. Ch. 24:513 (1932).
[4]Zeitfuchs—Ind. Eng. Ch. 18:79 (1926).

Fig. 1

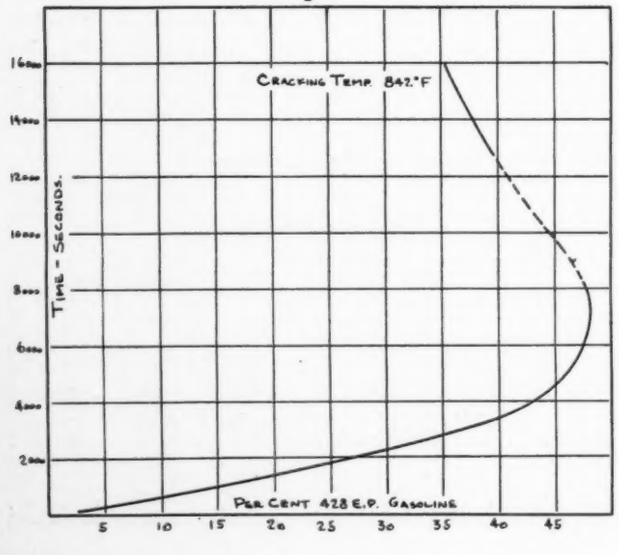



TABLE II

| % of gas vaporized | Bbl. of material at 900°F. and 400 lb./sq.in. Liq. | Gas | Total |
|---|---|---|---|
| 0 | 4.98 | .... | 4.98 (approx.) |
| 25 | 3.4 | 1.67 | 5.07 |
| 50 | 2.2 | 3.34 | 5.54 |
| 100 | 1.4 | 6.68 | 8.08 |

TABLE III

| Cracking temp. °F. | Max. yield (once through) | Time—seconds at max. yield | Phase | Stock | Reference |
|---|---|---|---|---|---|
| 700 | negative* | 20,000 | Liquid | Recycle | (6) |
| 800 | 40 | 14,000 | Liquid | Gas Oil | (7) |
| 840 | 48 | 7,500 | Liquid | Paraffin Wax | (5) |
| 932 | 31 | 1,000 | Vapor | Gas Oil | (8) |
| 1076 | 26 | 30 | Vapor | Gas Oil | (8) |
| 1184 | 23 | 3 | Vapor | Gas Oil | (8) |

*Note that this is for a recycle oil that already contains unsaturate materials.

The tar molecules as produced in the system are unsaturate and tend to combine with other tar molecules to produce still larger high-boiling molecules. In this manner they finally produce coke and little gasoline is recovered from them. The overall reaction of cracking involves both decomposition and polymerization. Fig. 1[5] illustrates the growing importance of polymerization as the maximum once-through yield of 48 per cent is approached. Finally, at times greater than 8000 seconds polmerization begins to govern and the yield decreases. Table III indicates how the relation of the two types of reactions to one another is affected by temperature. Commercial operation indicates that cracking cannot be conducted at more than about half the maximum yield per pass or coke will be produced.

Thus the recycle ratio for the so-called liquid-phase processes is governed by the maximum yields per pass as shown in Table III. If an ultimate yield of 50 per cent is expected, the total volume of liquid passing through the still must be 50 divided by (about) 20, or 2.5 times as much as the quantity of fresh stock. The ratio of the material entering the cracking zone to the fresh stock will be 2.5. For vapor-phase processes the recycle ratio is even higher, that is, about five. Commercially, there seems to be no advantage in operating at higher recycle ratios than these unless it is for the purpose of increasing the velocity in the tubes in an attempt to remedy a faulty design of the tube size or transfer rate.

**Ultimate Yields in Cracking.** The yields of products that may be expected from a given charging stock is no end of concern to the designer. Laboratory yields in batch equipment are of no value and about the only way to get dependable laboratory results is by the operation of an expensive replica plant. Since a replica plant is not practical for most companies, the following study of yields was made.

In all, 77 sets of commercial yield data and 16 sets of laboratory yield data were examined. Data from seven different kinds of commercial cracking plants were used and little difference between the yields from the different plants was evidenced except in the gas and unaccounted-for losses. The comparison of yields was made by tabulating the difference in the A.P.I. gravity of the cracking stocks and of the cracked tar for each of the different sets of data.

Equations of yields are as follows:

(1) 400-E.P. gasoline from gas oil or fuel oil = 25 + 1.5 (A.P.I. stock—A.P.I. tar).

(2) Gas and unaccounted-for losses = 0.45 (A.P.I. stock—A.P.I. tar).

(3) 400-E.P. gasoline by coking gas oil = 303 — 250 S, in which S = Sp. Gr. of stock.

(4) 400-E.P. gasoline by coking fuel oil = 331 — 300 S.

The accuracy of these equations is good[9] except for equa-

[5]Watermann and Perquin—J. Inst. Pet. Tech. 11:36 (1925).
[6]Leslie and Potthoff—Ind. Eng. Ch. 18:776 (1926).
[7]Cross Bulletin No. 25, p. 287.
[8]Geniesse and Renter—Ind. Eng. Ch. 24:219 (1932).
[9]The complexity of the problem must be realized and the correlation judged accordingly.

tion (2), which is in error by about plus or minus 50 per cent. The accuracy of the other equations may be judged by Fig. 2. It is interesting to note that the yield of gasoline from a fuel oil or a gas oil is the same if the differences between the gravity of the tar and of the stock is the same for both of the charging stocks. Thus a yield of about 46 per cent of gasoline will be obtained in cracking a 26-deg. A.P.I. fuel oil to a tar of 10 deg. A.P.I. and the same yield will be obtained by cracking a 31-deg. A.P.I. gas oil to a tar of 15 deg. A.P.I. The yields shown in Table IV may be expected when producing a 10-deg. A.P.I. tar.

It has been supposed that the gravity of the original stock or the base of oil from which it originated would affect the yield, but the data shown in Fig. 2 failed to disclose any relation of this kind. Thus the same yield is obtained in cracking a naphtha of 45-deg. A.P.I. to a 35-deg. A.P.I. tar as when cracking a 25-deg. A.P.I. gas oil to a 15-deg. A.P.I. tar.

The gas losses for different stocks are also interesting. It was found that the losses when cracking a gas oil were larger than when cracking a fuel oil for the same yield. The relative magnitude of the average losses is shown in Table V. The larger losses with gas oil may be explained by the more refractive nature of the lighter oils. Fuel oil can be cracked at lower temperatures than gas oil, so that the higher temperatures may account for the greater losses. An example of the method of determining the yields by the above equations follows:

EXAMPLE III.

A 24 A.P.I. M.C. fuel oil is to be cracked to produce 400-E.P. gasoline and bunker C. fuel oil having an A.P.I. gravity of 10 degrees.

Yield gasoline = 25 + 15 (24-10) = 46.0%
Gas and loss = 0.45 (14) - - - = 6.7%
Fuel oil by difference - - - - = 47.3%

These are the ultimate yields from the plant. To determine the yield of pressure distillate, approximations must suffice. For example, if the plant is operated so that the pressure distillate bottoms are blended directly with the tar, then the intermediate plant yields will be approximately as follows:

Pressure distillate 440 E.P. = 440/400 × 46 = 50.5%
Gas losses (same as above) - - - - - - = 6.7%
Tar before blending (by diff.) - - - - - = 42.8%

**Furnace Rates.** The rate at which heat is transferred in the cracking zone of a still is of great importance. At the same time several factors must be considered jointly, namely, (1) the rate of heat transfer, (2) the velocity, (3) the recycle ratio, and (4) the cleanliness of the stock. If the material entering the cracking zone contains even a trace of cracked tar, coking will occur under almost any conditions. Higher-boiling materials crack much more rapidly than lower-boiling materials so that the small amount of tar is subjected to a severe decomposition while the same length of time cracks the bulk of the stock to a properly mild degree. For this reason, many designers have suggested that the cracking stock be separately cracked in small cuts of narrow boiling range. Thus far, these suggestions have not been generally adopted because of the expense involved in the construction of several cracking plants for each stock.

TABLE IV
Yields when producing a 10-deg. A.P.I. tar

| Deg. A.P.I. of Stock | Kind of Stock | Difference in Sp. Gr. | Yield of 400-E.P. Gasoline |
|---|---|---|---|
| 15 | fuel oil | .034 | 34.0% |
| 20 | fuel oil or gas oil | .066 | 41.5% |
| 25 | fuel oil or gas oil | .96 | 48.0% |
| 30 | fuel oil or gas oil | .124 | 54.0% |
| 35 | fuel oil or gas oil | .15 | 60.0% |
| 40 | naphtha | .175 | 65.5% |
| 45 | naphtha | .198 | 70.5% |

TABLE V

| Difference in Sp. Gr. | Gas and unaccounted for losses | | |
|---|---|---|---|
| | Gas oil | Fuel oil | Average by Eq. (2) |
| .05 | 7 | 4 | 4 |
| .10 | 9 | 6.5 | 7 |
| .15 | 11.7 | 10.0 | 11 |
| .20 | 15.5 | 12.0 | 14.2 |
| .25 | 18.0 | .... | 18.0 |

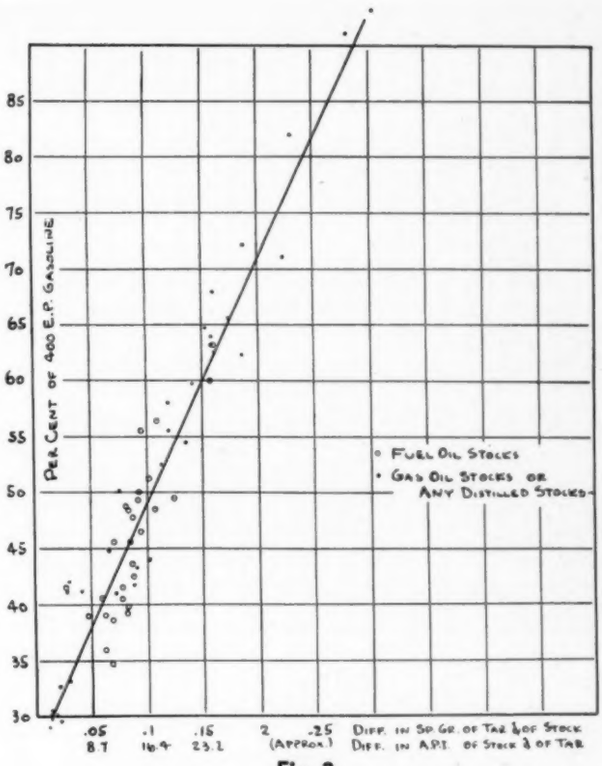
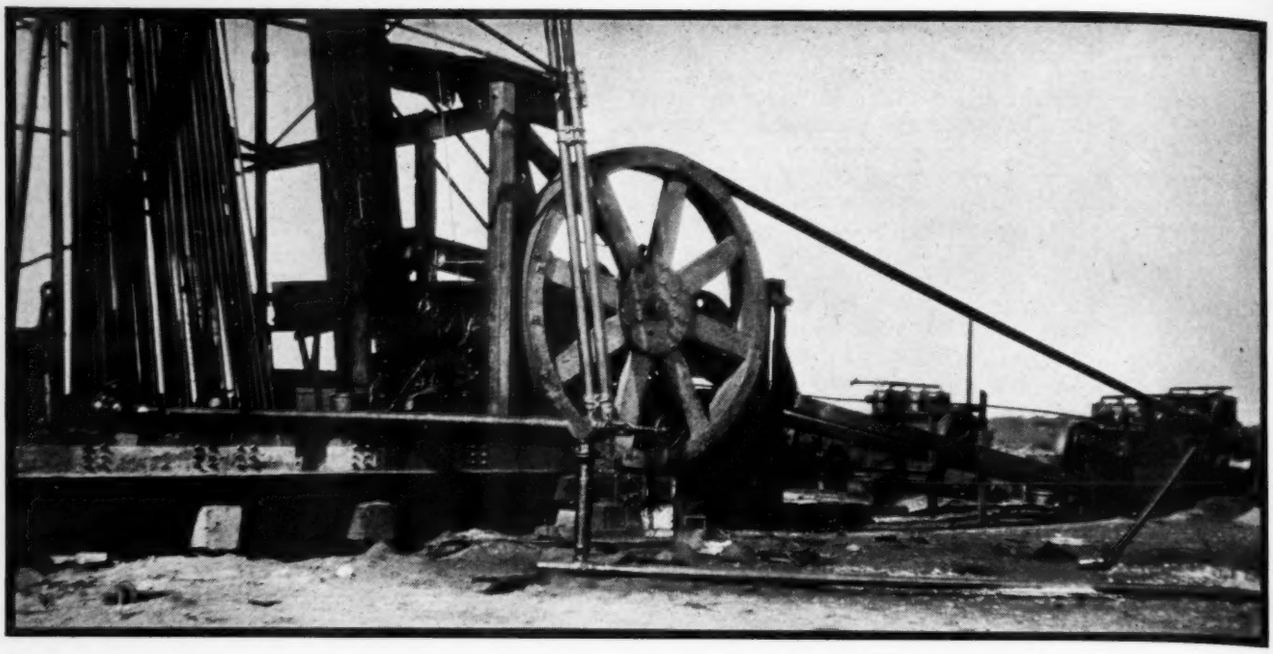



Fig. 2

The velocity and rate of heat transfer are inter-related. The rate of transfer must be kept low so that the film of stagnant material at the tube wall is not severely cracked so that coke is formed at the wall. However, the thickness of the film and its temperature can be reduced by increasing the velocity, but the usefulness of increasing the velocity is limited by the pressure drop, which increases all out of proportion to the increase in velocity. In commercial practice a velocity (computed at 60 deg. fahr.) exceeding five or six ft. per second is not practical because the charge pressure then exceeds about 1000 lb./sq. in. For such velocities a transfer rate of about 16,000 B.t.u. per sq. ft. of projected area per hour is satisfactory, although rates of 11,000 B.t.u. are often advisable. These lower rates are particularly useful in lengthening the cycle of run by reducing the rate of coke deposits. As soon as coke starts to be deposited in the tubes the operation must soon be halted unless a low transfer rate is used. The coke acts as an insulating film, which requires that the tube wall must be at a higher temperature in order to transfer all the heat that is delivered to it as radiation. Recall that the radiation falling upon a tube is not materially affected by conditions within the tube. The actual temperature in the tubewall can be computed by using the conductivity of the metal (and coke, if any is present) and the film transfer coefficient of the oil. As coke is deposited and the wall temperature exceeds about 1100 deg. fahr., the tube fails.

Different methods are used to reduce the transfer rate. Some reduce the radiation rates by adjusting the amount of radiant surface, others use flue gas recirculation and others route the material so that it leaves the still through the convection section where the rates are mild.



Side view of rig after well was completed

# Combination Portable Drilling Machine and Rotary Rig

By GAMALIEL GRAHAM
Drilling Contractor

A COMBINATION hook-up of a portable drilling machine and a standard rotary has proved a practical outfit for drilling shallow wells. The Graham Drilling Corporation has been using this combination drilling unit in the Monahans, Texas, district, where a 2537-ft. hole was completed in the actual drilling time of 27 days, including time out for repair work on machinery and to make several changes in sprocket ratio on the machine. When first equipped the rotary table was operated at a speed of only about 35 r.p.m. but by subsequent changes of sprockets the rotating speed was increased to 86 r.p.m. at 380 r.p.m. of the drilling engine.

With this hook-up the time made in drilling the well was about six days slower than that possible with a heavy rotary, two reasons for which were: first, the changes in adapting the hook-up were made while drilling; and second, with a heavy rotary rig the drill pipe can be pulled in fourbles, whereas with the standard derrick the drill pipe could only be pulled in doubles, thus necessitating twice as many breaks.

The rig consists of a No. 3 National machine, two Clark gas drilling engines; one engine supplying power for the drilling machine and the other supplying power to a Gardner-Denver mud pump through a 1240-chain transmission.

A 1230 chain runs from the 34-tooth sprocket (this being the usual sprocket on the line shaft of a National machine used to pull the bullwheels) to a 17-tooth sprocket on a jack shaft directly under the 34-tooth sprocket and bolted to the sills upon which the machine rests. This shaft also has a 42-tooth sprocket between the bandwheel and the sills that drives the rotary with a 1230 chain, through a 13-tooth sprocket on the rotary and a chain running parallel with the sills on the National machine. The shaft on the rotary had to be lengthened so as to make the center of the sprocket 6 ft. and 2 in. from the center of the hole to the center of the sprocket. On the crank side of the machine a 32-tooth sprocket takes the place of the crank and transmits power through a 1230 chain and a 15-tooth sprocket to the cathead on the first section of the machine.

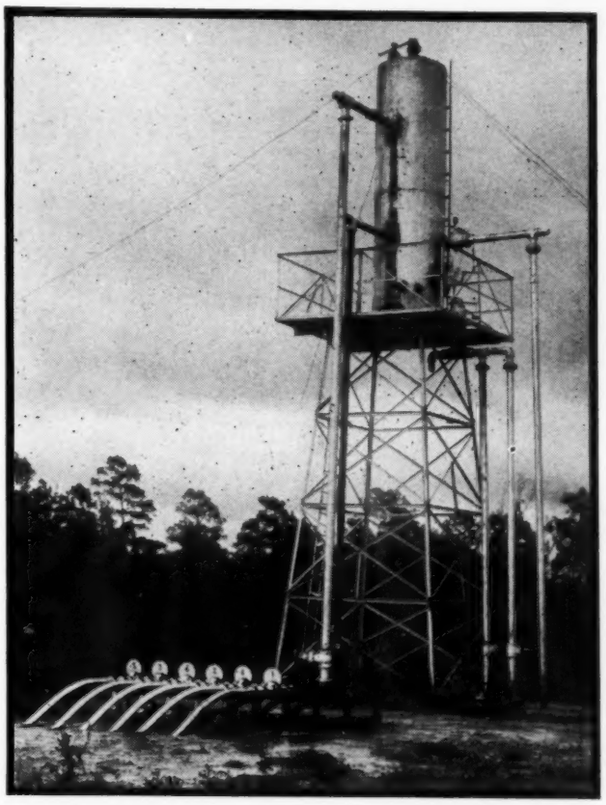
The calfwheel of the National machine was used for the drawworks and was found to work very satisfactorily. With it 6-in. drill pipe to 1800 ft. was handled on four lines and from 1800 ft. to 2200 ft. on five lines. At 2200 ft. 8-in. casing was set and the well finished with an 8-in. hole at 2537 ft. with 4-in drill pipe. This being the first venture of the Graham Drilling Corporation in this experimental work, it was decided to erect a standard 84-ft. derrick in order to have a place to stand the pipe.

The fuel bill for natural gas was $6.00 a day for the two engines. While with the drawworks it is a little slower (about one-third) coming out of the hole with the drill pipe than with the regular rotary we believe that in these shallow holes the combination hook-up explained herein is the most practical outfit to drill with. By using gas engines, boiler trouble and expense that occur because of the hardness of water in this area have been eliminated. Another advantage is that by simply changing the chain from the jackshaft to the bullwheels and putting up the beam, the rig is ready to go to standard tools.

# Reservoir and Producing Conditions in East Texas

By K. C. SCLATER

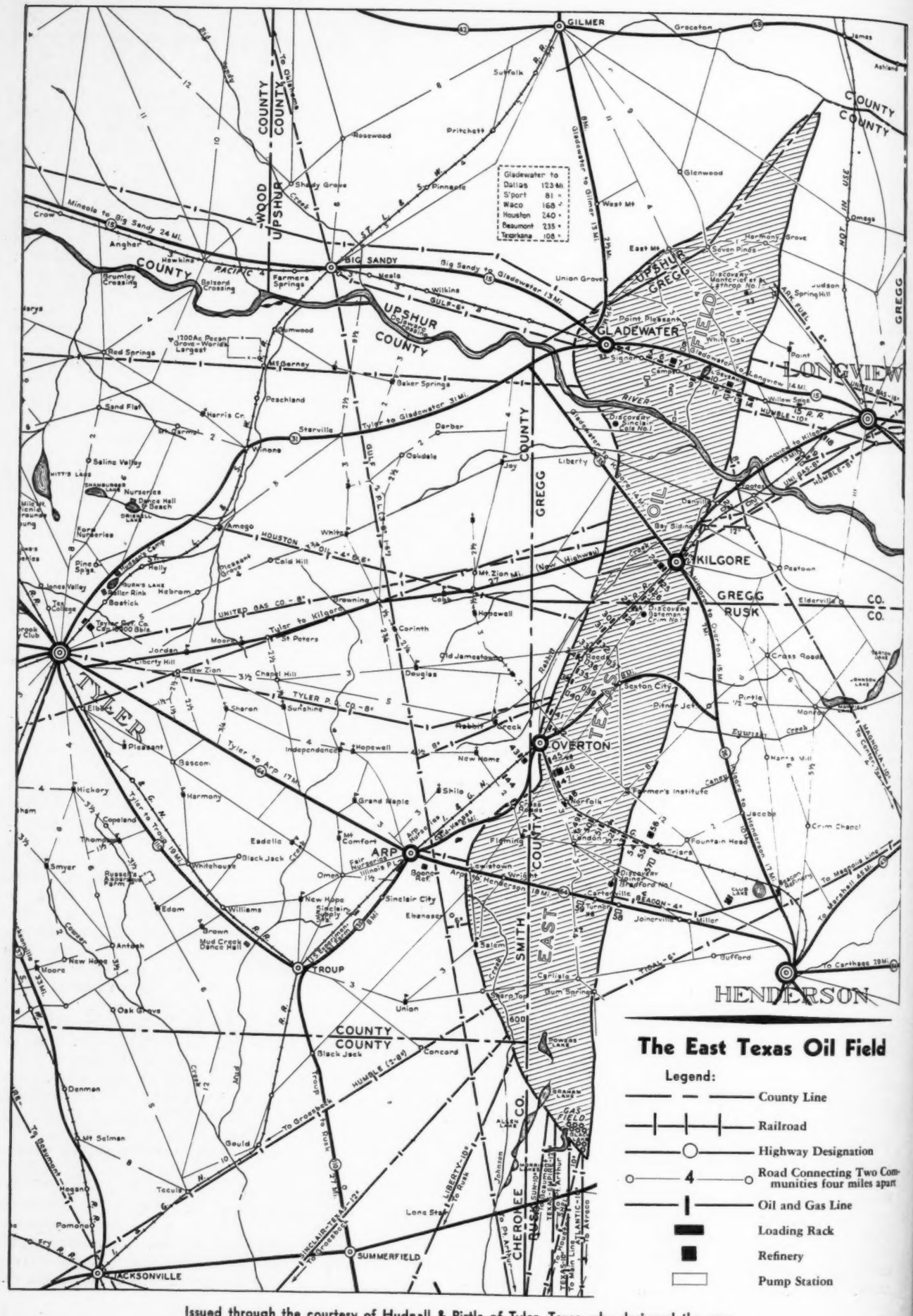
ENFORCEMENT of State regulations controlling production from the East Texas field appears now to be an accomplished fact. The practice of producing in excess of the daily quota allocated by the Railroad Commission was suddenly halted when Federal restrictions were placed on the interstate shipment of oil produced in violation of State regulations. Since July 18, and for the first time since attempts to prorate production have been in effect, the production has been held to the field's allowable. It marks a new phase in the productive life of the East Texas field. Although it is not known how much production the State authorities will allocate to the field under the new oil-industry code of the National Industrial Recovery Act, there is every assurance that compliance with State regulations will be scrupulously observed by all operators, and that, as a result, producing conditions in the field will undergo a vast improvement. With the amount of oil and gas produced definitely known a more accurate determination of the trend of reservoir conditions will be possible from production and bottom-hole pressure data than has been the case in the past. A reliable indication of the trend of flowing and pumping conditions in the field will mean much to the producer, for it will enable him to anticipate with a reasonable degree of accuracy what the reservoir conditions will be months from now, and, forearmed with this information, he can proceed with assurance on future plans for the efficient operation of his wells.



Well connections on manifold of separator on lease in East Texas, pumped from central power

**Curtailing production has reduced rate of reservoir pressure decline but water shows slight increase**

Although the net effect of curtailing the rate of production from the pool is to retard the rate of decline of reservoir pressure, and the rate of water encroachment, the decline of pressure goes on inevitably. Owing to the decreased rate of oil withdrawal a readjustment of subsurface pressure now is in active progress in the reservoir, striking evidence of which is the decrease during the last month of the average bottom-hole pressure drop per million barrels of oil produced. As of July 12, the reported average bottom-hole pressure for the field, as determined from some 270 key wells, was between 1216 and 1220 lb., giving an indicated average bottom-hole pressure drop at present of 0.8 to 1.0 lb. per million barrels produced. Wells in some parts of the field actually are showing no bottom-hole pressure drop, while others are even reported to show an increase of bottom-hole pressure. While this is to be expected, it has been responsible for erroneous assumptions with regard to the building up of reservoir pressure. Areas that have undergone excessive depletion compared with the average in the field have naturally suffered a large drop in reservoir pressure as a result. When the running of hot oil ceased the rate of production was slowed down and these depleted areas are now benefitting by an increase of bottom-hole pressure, owing to adjustment of pressures within the reservoir. What is actually happening is that the bottom-hole well pressure in badly depleted areas is building up at the expense of the pressure in the other areas of the field where a higher pressure obtains. The net result is a decrease in the average reservoir pressure. It will be recalled that about three months ago when the rate of production jumped to more than a million barrels a day, the rate of pressure drop increased sharply to about 5 lb. per million barrels of oil produced and then declined slightly from this figure as pressure conditions in the reservoir became adjusted to the increased rate of withdrawal. Conversely, when about a month ago, overproduction stopped and the rate of withdrawal was suddenly reduced, the rate of bottom-hole pressure drop showed a sharp decline to about 1.0 lb. per million barrels produced, but may, if not offset too greatly by pressure from water encroachment, be expected to show a slight increase as reservoir pressures become adjusted to the decreased rate of withdrawal. A distinction should be noted between reservoir pressure and bottom-hole pressure. Reservoir pressure takes into account the average pressure between wells, but the bottom-hole pressure is that actually observed at the face of the sand. It is obvious, therefore, that the average reservoir pressure is always higher than the average bottom-hole pressure. The greater the rate of withdrawal the




Issued through the courtesy of Hudnall & Pirtle of Tyler, Texas, who designed the map

greater will be the differential between the average reservoir pressure and the average bottom-hole pressures. Since it has been observed that at withdrawals of as low as 325,000 bbl. a day water does not encroach as fast as the oil is withdrawn, a drop in reservoir pressure is inevitable, and as the difference between the average reservoir pressure and the average bottom-hole pressure increases with the rate of withdrawal, any increase of bottom-hole pressure due to adjustment arising from a change in the rate of withdrawal occurs at the expense of reservoir pressure. It seems, therefore, that a drop of reservoir pressure of about 1 lb. per million gallons produced is inevitable at the present rate (575,000 bbl./day) of production.

Estimates regarding the minimum bottom-hole pressure at which wells will flow naturally in the East Texas field have been, and still are, of concern to operators in the field. Those engineers who have been studying pressures in the field are hesitant to take too positive a stand on this question. Factors that enter are many and variable, depending on the location of the well in the field. Bottom-hole pressure in itself is not a criterion of the flowing life of the well. Other underground factors, as permeability, structure, the presence of water and such like, must also be considered. It is a well known fact that as soon as water begins to appear in a well it is usually accompanied by a sudden decrease in the gas-oil ratio, as well as a decrease in gas-liquid ratio. This means that sufficient gas energy to flow the well, just when it may be needed most, is not available. This is one factor that is too often overlooked and one that in the past has lead to false conclusions in estimating the flowing life of wells. It is a factor of some importance in the East Texas field and one that accounts for wells ceasing to flow naturally even when the bottom-hole pressure is high.

Water conditions in the field have undergone a notable change during the last two months. More wells have been reported to be showing water recently, although many of these are showing only a trace. According to the Railroad Commission's report of July 21, 1933, 370 wells are showing water. Of these, 31 are dead wells, and ten are showing water that is comparatively fresh, the significance of which is that it is not from the Woodbine formation. A close estimate of the total amount of water being produced in the field from these 370 wells is 3000 bbl. a day. The actual total amount of water being produced is, however, believed to be much greater than this as there are some wells upon which remedial work is in progress and do not appear in the report that produce large volumes of water with very little oil. One well in the Gladewater area is reported to be capable of producing more than 1000 bbl. of water a day and the quantity of sand in the water has created difficulties that have necessitated, among other things, the use of a screen liner in an attempt to remove the sand trouble. Wells of this kind are not included in the estimate of 3000 bbl. just made. Encroachment of water is greatest on the west edge of the field, and there are several areas on the east edge of the field where water has made its appearance. These areas almost coincide with those having the greatest number of pumping wells, and areas where, it is evident, violations of proration regulations have been rife. Analyses indicate that the most of the water appearing in the wells on the west edge is from the Woodbine sand and contains as high as 66,000 parts per million of solids. These waters from wells on the west edge contain all the way from 21,000 to 66,000 parts per million of solids, indicating that mixed waters are present in a number of wells, and would lead to the conclusion that part of the water is coming from casing leaks. It is important that the producer know the source or nature of the water being produced, for by proper remedial work defects may be corrected and the well made to produce clean oil; besides, the flowing life of the well may be prolonged. Leakage of gas at the casinghead may be another reason that wells cease their natural flow prematurely and require to be "kicked off", swabbed or agitated to start flow. One company in the field, by repairing casinghead leaks, has been able to improve and prolong the flowing efficiency of its wells.

Revisions of estimates that have been made regarding the minimum bottom-hole pressure at which wells will continue to flow naturally have been largely the result of changes, observed from analyses on bottom-hole samples, in the methane content of the gas accompanying the oil. It is now believed by many that this average minimum pressure will be nearer 950 lb. rather than 400 or 500 lb., the estimated minimum made about two years ago. The amount of methane in solution is an important factor that will govern the flowing life, and much interesting information on wells in East Texas and other fields has been compiled to show this. Many wells in the field are approaching the point where

## Refer to East Texas Oil Field Map for Numbers Below

1—Sun Oil Company
2—Humble Oil & Refining Company
3—Gulf Production Company
4—Cherokee Chief Oil Company
5—Thurber Pipe Line Company
6—F. & M. Transportation Company
7—Sinclair Prairie Oil Company
8—The Texas Company
9—Illinois Pipe Line Company
10—Shell Petroleum Corporation
11—McMillan Petroleum Company
12—Slack Petroleum Company
13—Arkansas Fuel Oil Company
14—Pilot Oil Company
15—Simms Oil Company
18—Cranfiill & Reynolds
19—Danciger Oil & Refining Company and Bell Oil & Gas Company
20—Atlas Pipe Line Company
21—Atlantic Oil Producing Company
22—Shell Petroleum Corporation
23—Shell Petroleum Corporation
24—Kilgore Refining Corporation
25—Etex Oil Corporation
26—Texas Unity Oil Company
27—Oriental Oil Company
28—Marine Corporation
29—Houston Oil Company
30—Woodley Petroleum Corporation
31—Sinclair-Texas
32—Humble Oil & Refining Company
33—Stanolind Oil & Gas Company
34—East Texas Oil Company
35—Republic Production Company
36—The Texas Company
37—Liberty
38—Sabine Pipe Line Company
39—Gulf Production Company
40—Tyler Pipe Line Company
41—Toronto Pipe Line Company
42—Central Refining Company
43—Arrow Refining Company
44—Butler-Calhoun
45—Witherspoon
46—Overton Refining Company
47—Constantine Refining Company
48—Pilot Oil Company
49—Gulf Coast
50—Crown Pipe Line Company
51—Petroleum Marketing Company
52—Sinclair-Texas
53—Inland Waterways
54—Rusk County Pipe Line Company
55—Panola Pipe Line Company
56—East Texas Refining Company
57—Central Refining Company
58—Panola Pipe Line Company
59—Gulf Production Company
60—Sinclair-Texas

x = Casinghead Gasoline Plant

x1—Pundt & Ginsberg, Capacity 2000 gallons
x2—Harmony Natural Gas Co., Capacity 20,000 gallons
x3—Gladewater Gas Company, Capacity 7,500 gallons
x4—Humble Oil & Refining Company, Capacity 15,000 gallons
x5—Humble Oil & Refining Company, Capacity 30,000 gallons
x6—Lisbon Gasoline Company, Capacity 15,000 gallons
x7—Excelsior Refining Company, Capacity 16,000 gallons
x8—Gulf Production Company, Capacity 15,000 gallons.

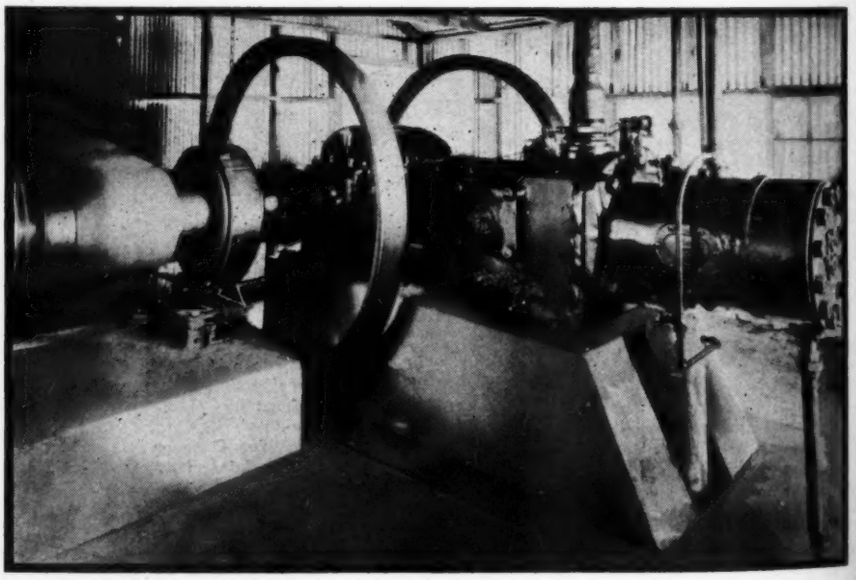
**Sturdy concrete foundations on an East Texas well**

they are quite sensitive to flow and care has to be exercised to maintain the column of oil behind the tubing at the proper level and not to upset this equilibrium while flowing the daily allowable production. If the well is flowed at too great a rate and the oil is withdrawn from behind the tubing instead of the formation, the balance is destroyed, which results in killing the well. It is found that the column of oil in the casing acts as a packer and, as stated, if the well is flowed too hard and this oil is withdrawn the packer effect is destroyed. On the other hand, if the well is flowed slowly the oil is withdrawn only from the pay sand and the column of oil in the casing automatically adjusts itself to the bottom-hole pressure. It has been observed that many wells in the field become very sensitive to flow as a bottom-hole pressure of 950 lb. is approached.

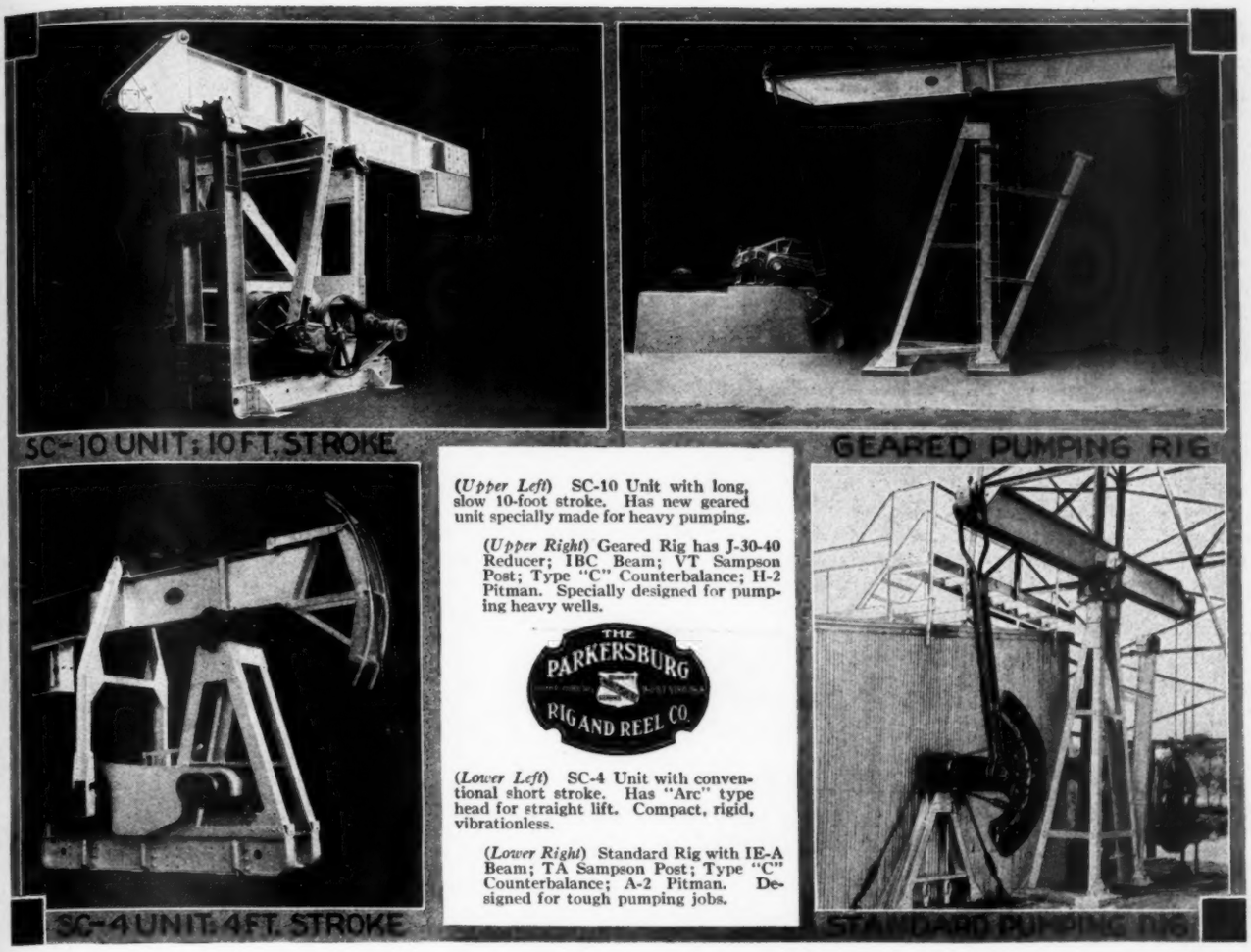
Several operators whose wells are in the "fairway" and where the bottom-hole pressure is still high are making preparations to equip their wells for the gas-lift in order to prolong the flowing life of the wells at least until next spring. One major company is now equipping 100 wells in the Kilgore-London district for producing its wells by natural flow, but using residue gas and kick-off valves to start the flow. By means of kick-off valves it will be possible to utilize residue gas from gasoline plants in the field at a pressure of not more than 300 lb. pressure. Gas connections to the wells will be taken off a 6-in. main line that traverses the area. Several different types of kick-off valves on the tubing will be experimented with, and these will be used for the sole purpose of kicking off the wells at low pressure in order that the wells can produce their allowable daily production. Other companies in the field are considering plans to equip their wells for gas-lift in order that they can flow them for several months longer and thus defer the pumping period. The use of kick-off valves for this purpose where residue gas at the required pressure is available is an economical expedient that will prove attractive to many operators. Although the Railroad Commission grants the use of the gas-lift only under special permission, and subject to withdrawal at any time, there are many operators in the field who will avail themselves of this special permission. One of the essential requirements of the Commission in granting permission is that only waste gas be used for the gas-lift, a provision that encourages the use of air where residue gas is not available.

There is quite likely to be a shortage of gas in the field for well operation when the pumping period arrives, and although this may sound highly improbable at the present time when so much gas from flowing wells is being burned in flares, it will be a highly important factor in well operation at a later date. This will be especially the case in wells that are making water. Fortunately, gas will be available in almost any part of the field from the United Gas Company's system of lines in East Texas, a map of which accompanies this article, at a monthly rate of 22½ cents per M cu. ft. for the first 200,000 cu. ft. and 11¾ cents per M cu. ft. for any greater volume than 200,000 cu. ft. per month. In this connection it is interesting to note that there are now eight gasoline plants in the field, the total capacity of which is 122,500 gallons daily, as follows: Humble Oil & Refining Company, two plants of 30,000 and 15,000 gal., respectively; Harmony Natural Gas Company, 20,000 gal.; Excelsior Refining Company, 16,000 gal.; Gulf Production Company, 15,000 gal.; Lisbon Gasoline Company, 15,000 gal.; and Pundt & Ginsberg, 2000 gallons. These plants may become an important source of residue gas for well and lease operation in the future.

Many operators have harbored the fear that because their wells are pumping or have to be given artificial aid to start them flowing they would be placed in the marginal well class. In this regard the Railroad Commission is taking a very lenient attitude and is adhering to the potential test data first taken in allocating the per well allowable. That



**Engine and clutch on pumping well in East Texas. Note the permanent setting**




*(Upper Left)* SC-10 Unit with long, slow 10-foot stroke. Has new geared unit specially made for heavy pumping.

*(Upper Right)* Geared Rig has J-30-40 Reducer; IBC Beam; VT Sampson Post; Type "C" Counterbalance; H-2 Pitman. Specially designed for pumping heavy wells.

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*(Lower Left)* SC-4 Unit with conventional short stroke. Has "Arc" type head for straight lift. Compact, rigid, vibrationless.

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# *When Bottom-Hole Pressures Fall..*

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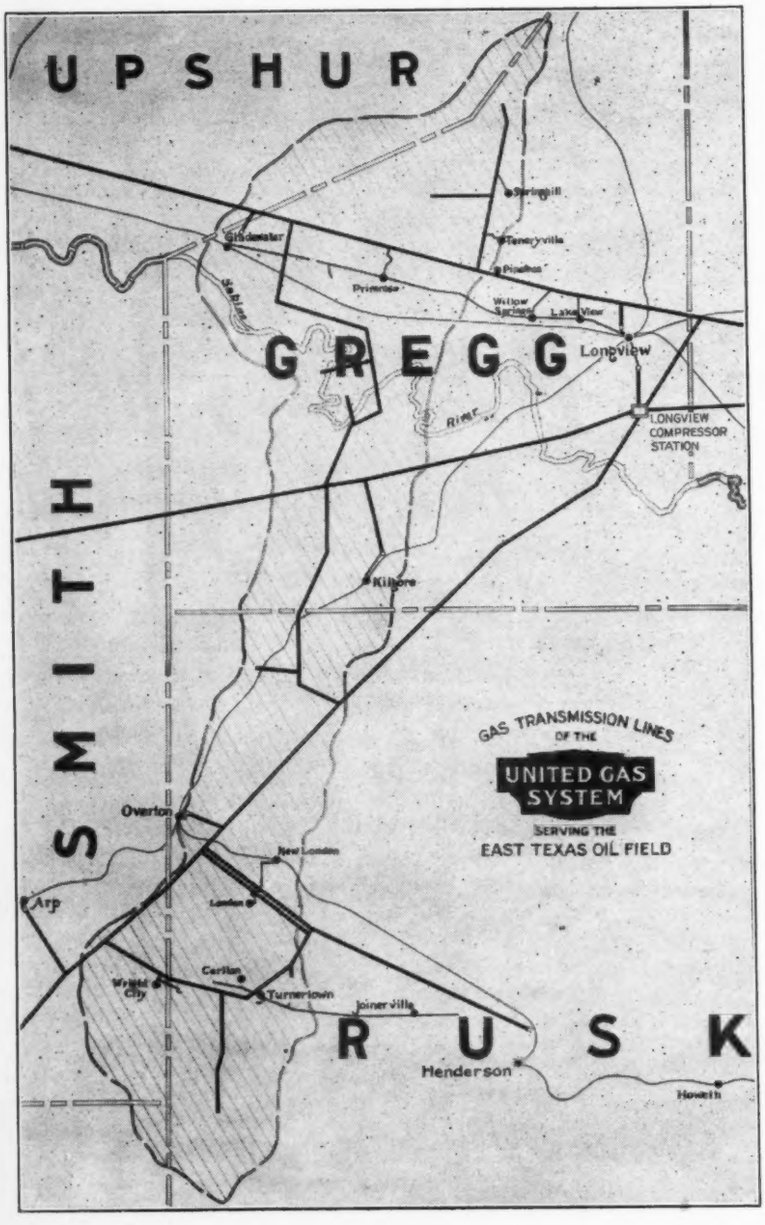
many of these wells have to be pumped now is no fault of the operator but is the result of offset operators violating proration regulations, thereby causing a reduction of reservoir pressure in these areas that has resulted in all wells in the immediate vicinity ceasing to flow naturally. In the face of these conditions it manifestly would be unfair to the operator who has abided by proration regulations to penalize him because of an offset operator's wrongdoing. To allow wells of this class only 20 bbl. daily under the marginal well ruling would be an added injury and hardship. It will not be the policy of the Railroad Commission to penalize all pumping wells as marginal wells, instead they will be prorated accordingly as they fall within the pressure contour lines of key wells established by bottom-hole pressure tests and the corresponding potential flow.

Installation of pumping equipment is actively in progress and there is every indication that this activity will gradually increase in volume in the coming months. Pull-type jacks are being installed almost exclusively and shackle rod lines of 7/8-in. and 1-in. diameter. On jack pumping wells the average length of stroke being employed varies from 30 to 36 inches. Twin-cylinder gas engines are popular on central powers. About 8 hp. is the estimated average power required per well. In the Carlisle district there is one power with 19 wells on it, and in the London district another with 14 wells on it. Both of these are geared powers, and on the latter power more than 500 yards of concrete was used in equipping the wells and installing power.

One of the noticeable signs of progress in installing well equipment is the almost universal use of concrete for foundations. A company has recently been formed for the delivery of Transit-Mix concrete in the field. Delivery of concrete prepared mixed on the job is an innovation in oil field practice and is a healthy indication of the remarkable progress being made in the methods of installing equipment. It is difficult with a limited personnel to mix and pour concrete in the field and expect to find the technical skill required to obtain a concrete that will have the consistent strength necessary. The old methods of mixing aggregates for concrete are rapidly becoming obsolete, especially where the quality of the concrete plays the important part it does in pumping machinery foundations. As it is not always practicable in the field to compute and measure the water content going into the concrete, the result is that each batch of concrete poured will vary according to the knowledge and care of the foreman on the job. It is important to maintain a proper water-cement ratio for a good sound job. Each truck-load of concrete delivered from these plants, of which there are three in the field, is charged with sand, gravel, and cement that has been carefully weighed and the moisture content of which has been computed. These aggregates go into the truck dry and are thoroughly mixed before any water is added. Water for the batch, being measured, is put into a water tank above the mixer and is allowed to enter the mixing drum on the truck through a perforated pipe while the mixer is turning. The batch is generally mixed when the truck is within five or ten minutes of its destination. This method of introducing water prevents any portion of the mix from becoming too thin, and the long period of mixing before discharging insures uniform strength and consistency. In the last few years, concrete of the proper mix is gradually replacing the concrete of arbitrary mix, such as 1-2-4 mix, because these proportions must be changed as the grading of materials changes in order to obtain a dense concrete of the proper predetermined strength. All batching of Transit-Mix trucks is under the strict supervision of the laboratory, and all materials bought are carefully inspected before being accepted for use. This service in the field to companies and contractors has speeded up construction work and at the same time improves the general quality of the concrete in use. This company has three plants in the field, one at Camp Switch, Seven Pines, and Kilgore, respectively.




Attractive electric power rates are available in the field, whereby with a large load and a good power factor a company may obtain a unit rate of one cent or less per kw.-hr. on the monthly power bill. These favorable rates are stimulating interest in the adoption of electric power for pumping wells in the field. The fact that many of these wells are being electrically equipped for pumping, strict attention will be paid to maintaining a steady load and uniform operating conditions, which will contribute toward reducing the power bill and give an advantageous rate per kw.-hr. for this service. Pulling of the wells will likely be done by portable pulling equip-

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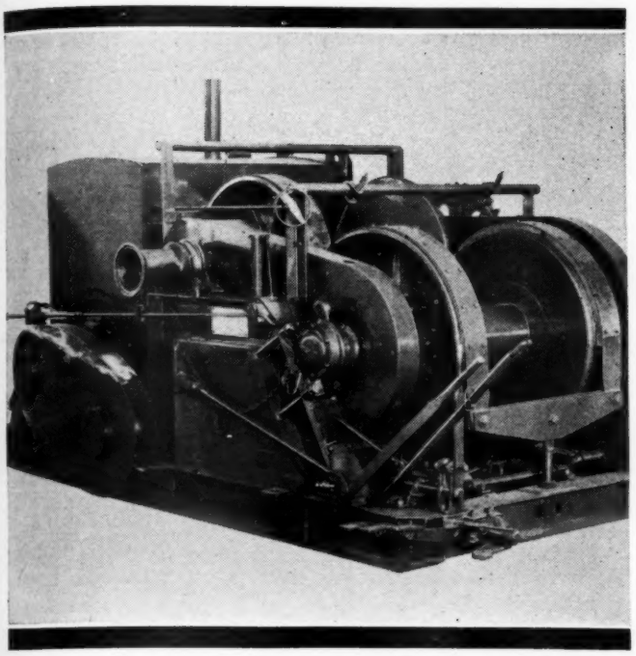

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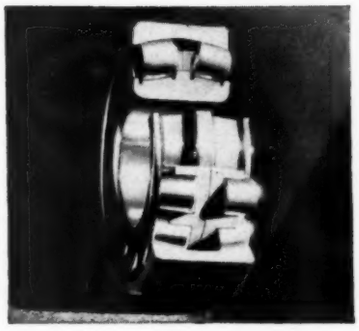

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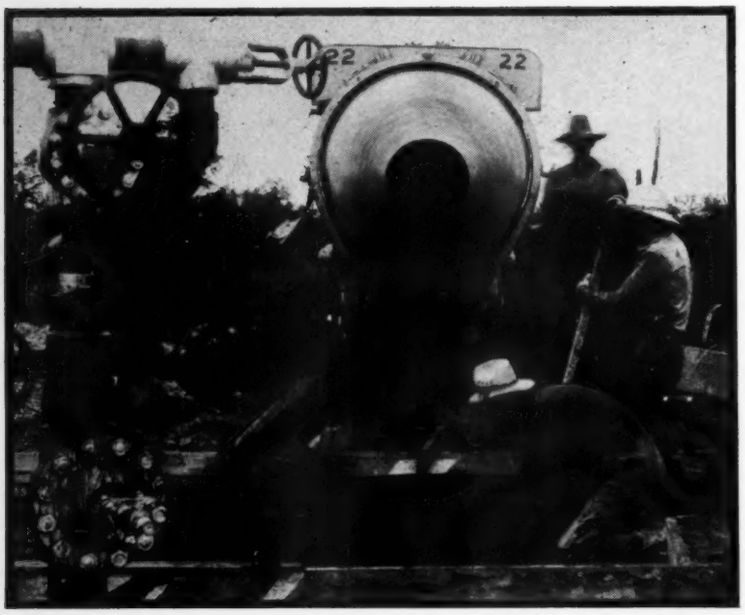


**Pouring Transit-Mix concrete direct from truck to foundations on well in the East Texas field**

ment as it is a job that in regard to power requirements has wide fluctuations and may not be conducive to a low peak load and a high power factor. At the present time very little is known regarding what well requirements will be in the way of service when the pumping stage has been reached, and since it is anticipated that water and paraffin troubles are likely to be a source of trouble in many parts of the field, frequent pulling jobs may be necessary.

Another interesting development is the installation of several small lease plants for the generation of electric power for pumping wells. One independent operator, Cox & Hamon, is installing two such plants on its leases in the Gladewater area, using 3-cylinder vertical engines of 225 hp. for driving the electric generators, while a major operator in the field, the Stanolind Oil and Gas Company, has plans made for the installation of 19 plants on its leases in the field for the generation of electric power for pumping. These latter will have 100-kw. electric generators driven by 165-hp. twin-cylinder gas engines, and the wells will be equipped with triple-rated motors of 9-15-25-hp. rating.

Comparative quiet prevails in the field at present and there is evident a slight lull in activity, which is attributed to the fact that many operators prefer to wait until they see what the provisions of the industrial recovery code have to offer and also how they will affect producing operations in the East Texas field. Whatever happens, it is believed that the allowable production from the field is not likely to be greatly increased, if it is increased; rather, there is the possibility that it may be reduced. In any case the rate of bottom-hole pressure drop for the field is not likely to exceed ½ lb. a day if the present rate of production is not exceeded.

One large operator has 200 wells producing through tapered tubing, the smaller strings of which are made up of 1-in. and 1¾-in. tubing and the large strings of 2-in. and 2½-in. tubing. No paraffin trouble is encountered in the larger strings of tapered tubing but in the strings of smaller diameter frequent cleaning is necessary. The use of automatic scrapers in the larger strings is sufficient to keep them free of paraffin and saves the job of pulling that is necessary in the smaller strings.

Estimates made by engineers several months ago that many wells would stop flowing by the end of July, based on the assumption that the uncontrolled rate of flow from the field at a million barrels daily or greater would continue, were not far off the mark. That the field has been curtailed and held to within its allowable production is the only reason that this was averted. The real determinal effects are beginning to be felt, one of which is the increase of water.

Under present conditions, when—to quote one reason—commodity prices are on the increase, the placing of orders for equipment well ahead of requirements is a wise course to follow. It is known that some manufacturers are being pushed to fill the orders on hand. With the situation that confronts the producer of having to make an estimate of what his wells will do between the coming November and April of next year and the fact that immediate delivery on equipment may be delayed or not be possible, there is no disguising the facts regarding the sane course being pursued by operators in the field in making immediate preparations for equipping wells in doubtful areas of the field. Those who are financially able or can afford to do so are equipping their wells and thus are making no attempt to gamble with the future. Adding to the uncertainty of the immediate course of events the operator is confronted with possible changes by conforming to the provisions of the Industrial Recovery Act, both from the standpoint of the labor cost and the quantity of oil his wells will be allowed to produce. There is reasonable assurrance, however, that oil will bring a better price than it has in recent months passed that will more than compensate for a reduced allowable. Moreover, he can look forward to a sustained daily rate of production and a higher ultimate recovery.

At this writing more than 10,300 wells have been completed, about 1700 of which it is estimated have been equipped for pumping and about 1400 more in the process of being equipped. Included in this group are the wells on the 55 geared powers and nine bandwheel powers already installed. There are 500 flowing wells requiring occasional aid by swabbing or agitating. The average bottom-hole pressure is 1200 lb. and the average bottom-hole pressure drop about 1 lb. per million bbl. of oil produced. Under the proration schedule of July 16, 1933, of the Railroad Commission, the highest per well allowable is 102.6 bbl. per day, the lowest, 20.0 bbl. a day and the average 56.4 bbl. a day.

Drilling of wells continues at the rate of about 25 completions weekly. It is expected that the area will be drilled up with an average spacing of about 8 to 10 acres per well, which would give an ultimate total of 12,500 wells in the field. With 10,325 wells already completed and 12,500 as the ultimate number of wells, at the rate of 25 completions per week drilling of the remaining 2,175 wells would not be completed until about the end of 1934. The ultimate effect of a greater number of wells in the field, assuming no increase in the field allowable, would be to give a better distribution of reservoir pressure and the maintenance of a more uniform pressure over the whole field.

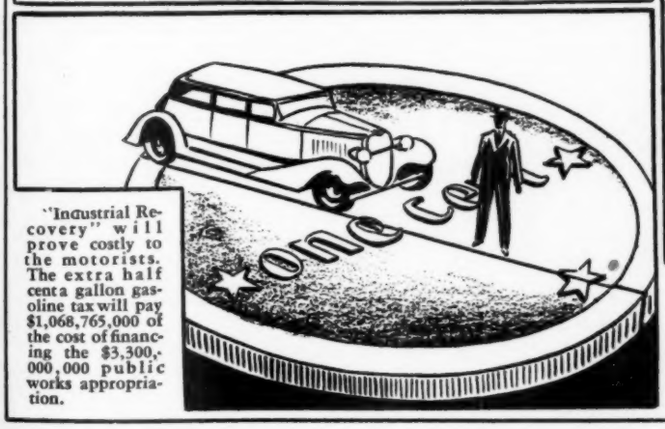
Data on bottom-hole pressure decline taken on wells surrounding a key well on which potential flow tests were being made gave a definite indication of the extent of the zone of interference at different rates of flow. This information is tangible evidence in regard to spacing considerations that could very well be applied in practice in other fields. Tests of this kind could be used in a field where it is known that the sand conditions are reasonably uniform and the results adopted as a guide in well-spacing studies. For inevitably, this will be an important consideration in the development of oil fields in the future.

# STRANGE.... *but* TRUE

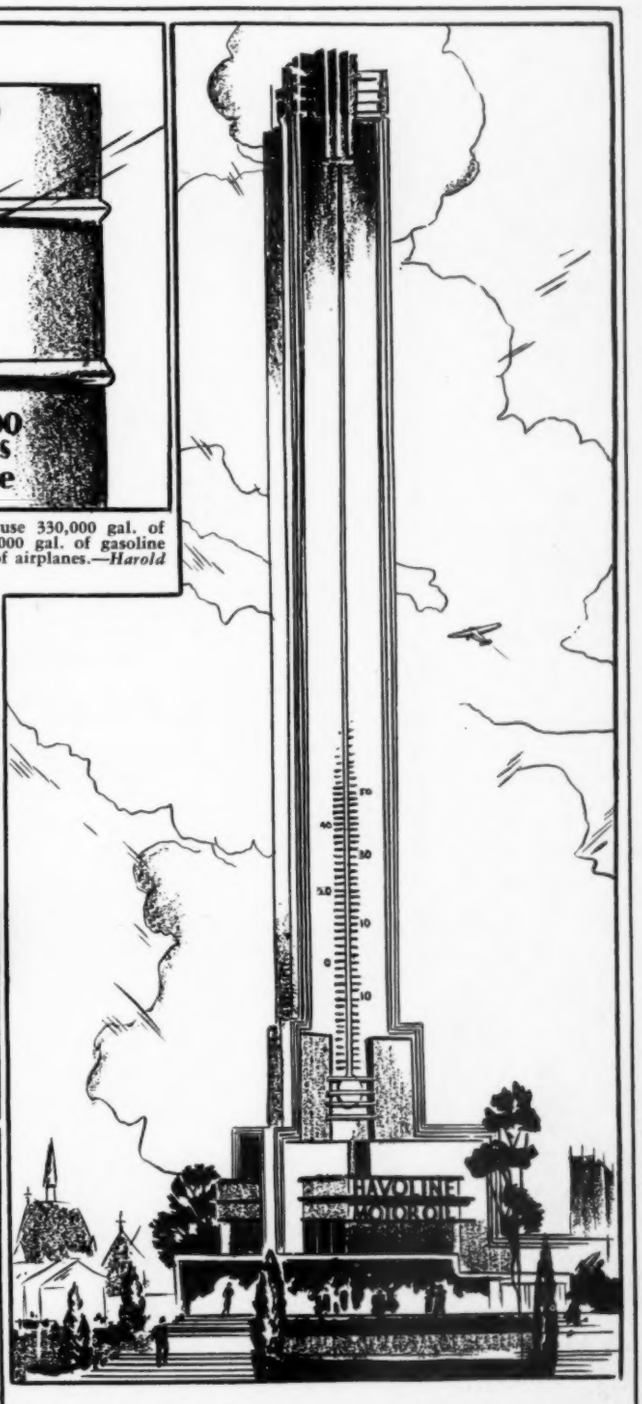
## HAPPENINGS IN THE PETROLEUM INDUSTRY

The United Air Lines use 330,000 gal. of lubricating oil and 8,000,000 gal. of gasoline a year in fueling its fleet of airplanes.—*Harold Crary*, Chicago, Ill.

The first pipe line of which there is any actual account in history was constructed around 525 B. C. in Arabia. It was made of ox-hides and other skins and extended from the river Corys to waterholes dug in the arid desert sections. Cambyses, King of Persia, had the line built to furnish water for his troops in passing through the country.—*The Lamp*, April, 1933.



"Industrial Recovery" will prove costly to the motorists. The extra half cent a gallon gasoline tax will pay $1,068,765,000 of the cost of financing the $3,300,000,000 public works appropriation.




A thermometer at the booth of Havoline Motor Oil at A Century of Progress is 200 ft. high and has numerals 3 ft. in height. The columns that indicate the temperature are made of neon tubing electrically operated by a master thermometer. Ten miles of wire, 3000 ft. of tubing, 60 tons of steel and several hundred feet of pressed wood were required to build this largest thermometer of them all.

# Some General Properties of Clays Used in Contact Treating

By L. C. TRESCOTT
Development Engineer

IN these times when more refiners are turning to the contact treatment of lubricating oils the matter of clays takes on considerable importance. It is true that each job is a problem by itself. Many variables come in; matters of decolorizing value of the clays; filter flow rates; the action of the clay on the oil to give the proper tests; oil retention by spent filter cake; as well as many features on the economical side. The importance of proper acid treatment or preparation for clay treatment must also be taken into account. All too often the acid treat is decided on and the clay treatment simply put on to finish this out. Such procedure is a mistake, as the acid and clay treats should be considered together if the best results, both as to quality and economy, are to be achieved.

Fine decolorizing clays are divided roughly into two classes: natural clays and acid-treated clays.

Natural clays can generally be classed as low-powered, though in rare cases such clays have been found that are of a relatively high decolorizing value. Such samples, however, come from isolated beds, and will hardly be of concern to the average refiner. Of all the natural clays probably the most widely used are the Fullers' Earths, the largest deposits of which are found in Florida and Georgia, smaller beds being found all over the country.

**For best results acid and clay treats should be considered together**

Where the neutralization only of an acid oil is required, or high quality steam or demulsibility tests are to be made, the use of a Fullers' Earth should be investigated. As decolorizers they do not rate as highly as acid-treated clays, but for the purposes named they are much better. In the decolorization of oils by the percolation method, coarsely ground clays are used. These are dried or burned before charging to the filters as the oil is usually decolorized at atmospheric temperature, or at least below 150 deg. fahrenheit. In contact treating where the treating temperatures usually run from 250 deg. fahr. up, excessive drying or burning is unnecessary. It must be noted, however, that increased moisture does not usually increase the decolorizing efficiency of the clay. In this respect they differ from the acid-treated, high-powered clays.

The acid treatment of Fullers' Earth as a rule does not increase its decolorizing power to any extent. An acid-treated Fullers' Earth, however, can be reburned a greater number of times than the untreated product, when the sizes used in percolation filtration are treated. Reburning fine clays has shown such small possibilities of real success that the value of the acid treatment of Fullers' Earth for any purpose is in doubt.

In Utah and Nevada are found clays that are not Fullers' Earths, but are equal or perhaps slightly better than the best of the latter when used in their natural state. They are solid enough that they may be ground for percolation clays. They reburn well in that size and at the same time the fine grades are of such quality that they may be acid-treated to a high-powered clay. The development of most of these deposits on a large scale is yet to come.

Scattered over the country are many deposits that are available for the processing of petroleum oils. They vary in decolorizing power all the way from the low value of kaolin or china clay to the high value, which in the case of a natural clay, available to the average refiner, would be that of a Fullers' Earth. In determining the value of such clays for contact filter work some of the details that should be investigated carefully are pointed out below:

As a rule a natural clay that has an alkaline reaction or will show a pH value greater than seven, will be found worthless. Clays of this type are not good decolorizers, and more often than not they will give an impervious cake on the filter. But, as an example of the sometimes contradictory character of clays in the Mohave Desert region in California there is a single deposit that, out of several thousand samples tested from all over the world, is decidedly alkaline, whose filter cake gives excellent flow rates and whose decolorizing quality is slightly under that of a high grade acid-treated clay. Many natural clays carry excessive colloidal matter, and fines of such nature as to cause an impenetrable filter cake. This gives a low flow-rate through the filters and as a rule such a spent filter cake has a high oil retention. Fresh mined Fullers' Earths are usually satisfactory enough in this respect, but fines that have been stored in piles, in the weather, are likely to be broken down and slime easily to give a bad cake. Fineness tests unfortunately do not mean much here. Merely because material passes a 300-mesh screen does not mean that it will form a bad cake.

Tests run with the oil under actual temperature conditions on a suction filter will often show comparative filter rates and give some idea of the quality of cake formed. Retained oil can also be determined from this cake, provided the same thickness of cake be built up on the small filter as is formed on the full-scale apparatus. A thin cake is pulled much more dry than a thicker one. The cake sample is extracted in a regular Soxhlet laboratory extractor using petroleum ether as the solvent.

The best grade of acid-treated clays generally have a Bentonite base. Bentonite is a sedimentary mineral of rather indefinite composition. It is formed when volcanic ash is deposited under water. The leached and weathered product is

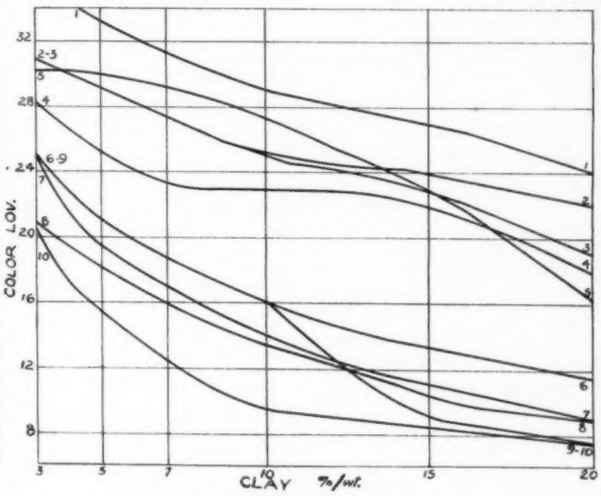
found in old lake beds in our western deserts, quite extensively in Canada; and there is a deposit that extends from Birmingham, Ala., to a point as far north as Perry County, Ohio.

There is a considerable variation in Bentonite deposits and but few of them have any value as decolorizers in their natural state. The best Bentonite stocks in this country that have been developed to any extent come from the Death Valley region of the Mohave Desert in California, and from the Otay Mesa in San Diego County, California. Other high class Bentonites are sprinkled over the west, and the Southern Appalachian deposits also will give high-powered clays when acid-treated.

There is nothing particularly complicated in the acid-treatment of clays. The raw product is roughly pulverized and fed to a treating agitator that has been charged with a solution of sulphuric acid of a strength of 18 to 25 per cent. Approximately 50 per cent by weight of the material charged, of 100 per cent sulphuric acid is required. In practice a weight of 66-deg. acid equivalent to half the weight of clay to be treated is taken. This is added to water to make a solution of the required strength. Where the clay is treated at an oil refinery the dilute acid that has been separated from the sludge can be used as it comes from the separators. This acid is a little dark but that seems to make no difference in the treated clay. It takes about eight hours of cooking with open steam to complete the treat. When this is finished the acid salts are drawn off and the clay is given several washes with water. It is finally filtered and dried, and is then ready for use.

The matter of moisture in acid-treated clays has been one of some controversy. Purchasers sometimes insist on a low water content. With most clays of this type it is a mistake to go too low. Naturally no one cares to buy and pay freight on water, but with an acid-treated clay it is decolorization that is being purchased and not just so much material by weight. Reduction of water content often means a reduction in decolorizing value. Loss in quality often more than balances the saving in weight by a lowered water content. For that reason, caution should be used in setting a specification on water content. Some acid-treated clays will carry as high as 30 to 32 per cent by weight of water, will seem perfectly dry as far as handling is concerned, and will show an efficiency 30 per cent higher than the same clay that has been dried to 12 or 15 per cent. It would seem that this is not simply mechanically held water that wets the clay. Water can not be added to the dried clay and an increase in efficiency shown. The water content is apparently a part of the composition of the mineral on which the coloring matter of the oil is deposited. Many minerals with widely different properties differ only in water content so far as composition is concerned. It is not improbable that such is the case here, and that a reduction of water content gives a mineral composition that operates less efficiently as a decolorizer of petroleum oils than a composition of higher water content.

**Decolorizing Characteristics of Fine Clays**




1. No. 1 French Fullers' Earth.
2. No. 1 Utah Clay.
3. Georgia and Florida Fullers' Earth.
4. No. 2 French Fullers' Earth.
5. English Fullers' Earth.
6. No. 2 Utah Clay.
7. Arizona Clay (acid treated).
8. No. 2 Utah Clay (acid treated).
9. No. 1 German Clay (acid treated).
10. No. 2 German Clay (acid treated).

The action of a clay in decolorizing an oil is also a matter of some controversy. It appears that there are two actions involved. There is a catalytic action, in which a chemical change takes place in the oil. With this goes the adsorption or deposition of the coloring matter on the clay.

The difference between a high-powered clay and one of lower decolorizing power lies not in the fact that its capacity for adsorbed material is greater but in the fact that due to its catalyzing or polymerizing activity, the coloring matter in the oil is concentrated and so put in that it is more easily deposited on the clay. Coloring matter extracted from clays that have been used on the same grade of light oil will, in the case of a Fullers' Earth, be a light black oil,while the extract from a high-powered clay will be in the nature of an asphalt, or may run almost to a coke. From this it would seem that the action of the high-powered clay is essentially polymerizing or catalytic, while in the lower-powered clay the action is almost wholly adsorptive.

German high-powered clays differ from our western product largely in texture. In general, they are slightly better in quality, though the best of our clays will equal them. Our American clays go extremely fine on acid treating, but the German product is coarser and for extreme fineness it must be ground. The German clays are more gritty, are harder on pumps and equipment, and as their particles are larger the filter flow rate is much higher. They are unsuited for use on a vacuum filter as the filter cake is brittle and cracks easily, letting excess air through to cause oxidation and loss of color in the oil being filtered. Where a partial reactivation of the clay by reburning is desired these clays will give better results than our American products. This is probably due to the larger and harder clay particles.

Generally clays are used only for decolorization, but in some cases they are used for the neutralization of an acid-treated oil where little or no decolorization is expected. This oil has generally been acid-treated to color or is to be further decolorized by percolation. In such a case a low-powered, inexpensive clay is generally used, though care must be taken that the clay is not alkaline. There is sometimes a mistaken idea that neutralization of this sort is a chemical neutralization, such as occurs when soda is added to the sour oil; that alkalinity in the clay is a distinct advantage; but such is decidedly not the case. Neutralization here is the result of the action of heat and clay on the acid bodies, and the subsequent removal of the same by adsorption on the clay. Alkalinity in the clay or any constituent of the clay that gives chemical neutralization is usually due to calcium, iron, or magnesium compounds. The neutralizing action of these compounds on the acids in the oil gives soaps that are oil soluble. They are not entirely removed from the oil by the clay and their presence in the oil will ruin any steam or demulsibility test that is put on it, and if the oil be subjected to an oxidation test the result is likely to be bad.

Even where clay is used for neutralization only, it is sometimes more economical to use a high-powered clay.

Where a smaller quantity can be used it is possible that the lower oil losses and the higher filter rates will balance the higher cost of the clay. This, however, is a problem that, like everything else in the oil business, will depend on the job at hand.

While high-powered clay is a superior decolorizer there are many cases where color alone is not the most important consideration. Transformer oils, turbine oils, etc., are subjected to oxidation tests, demulsibility tests, etc. It seems that the greater activity of the high-powered clay, while it does give a high decolorizing value, works against these tests. Practically all the material polymerized or otherwise acted on by the clay, is adsorbed and taken out of the oil, but minute traces apparently remain and these work to throw the oil off test.

In general, it may be said that for transformer oils, turbine oils or any oil that is to undergo such tests, a low-powered clay should be used and the treating temperatures should be kept as low as possible. This cuts polymerization by the clay to a minimum, and makes the operation as nearly as possible one of adsorption only.

Every proposition for the application of fine clay stands by itself and it may be said that there is no general method of clay evaluation that will cover every point. The safest way to judge a clay is to use it under the conditions that hold in the process in which it is to be used and set its value from the results. Obviously, this means the setting up of a method of evaluation, or the modification of a method for each particular process. Various pseudo-scientific methods on general clay evaluation have been proposed, but it is a noticeable fact that anyone with real experience with clays hesitates to endorse such a method. Between the variables in the oils and in the clay itself it is not possible to set general standards that are even reasonably exact; and clay that gives good results under one set of conditions will sometimes give negative results if those conditions are changed.

With sufficient experience in actual work it is possible to judge the comparative value of a clay, and what is more important, this same experience will indicate the points where trouble may be expected. The value of any clay evaluation depends entirely on the skill and practical background of the operator doing the work and interpreting it.

On Fig. 1 are shown the decolorization characteristics of ten representative clays of this country and Europe. Here the percentage by weight of clay used is plotted against the Lovibond color of the oil after clay treating. The work in this case was done on a heavy coastal red oil that had been acid-treated and neutralized. The color of the stock was 32 Lovibond. This sketch is given to show the comparative ratings of the clays and this rating will hold even when other oils and other methods of treating are used.

The application of the clay direct to a properly treated sour oil instead of a treated and neutralized oil would give lower colors all around, and would bring the natural clays slightly closer to the treated clays, but the general comparison between them would still hold good. This method of showing clay values is very satisfactory. Any color system may be used instead of the Lovibond and it gives the color reduction directly in terms of the clay required. Logarithmic paper has been used to plot these data, but there is no good reason for this. The curves in any case are not straight lines but of the same general form as shown here. Attempts to fit these data to mathematical formulae are also of little real value. It is much safer to plot it on straight coödinates, and then by experience and judgment put a value on the clay. As a rule such values are set, regardless of the method of testing, by comparisons with some clay in use at the time, which forms a convenient and well-known standard.

# Oil Supply Men Perfect Organization and Adopt Code

EXECUTIVES of petroleum equipment supply companies, at a two-day meeting in Dallas, perfected an organization and adopted a code under which the oil supply industry will function in the National Recovery program.

W. L. Childs, general manager of Reed Roller Bit Company, Houston, and J. A. Crawford, president of Republic Supply Company of California, Los Angeles, were elected president and vice-president, respectively, of the association, which will be known as the American Petroleum Equipment Suppliers' Association.

The adopted code provides for a 40-hour working week and a minimum wage of 40 cents per hour. Sale of equipment at prices below cost was ruled out, with a provision made for handling discontinued lines of obsolete or surplus stocks where a member is willing to sell below the prices. Each member is to file within 20 days a minimum price list with discount sheets, and terms and conditions of sale, with notice of such filing to be sent by the association to all members with similar products or service. Such other members may then file revisions of minimum price lists with discount sheets and terms and conditions of sale if they desire. Violation of the code is subject to a fine of 20 per cent of the invoiced price of any products in connection with which such violation occurred.

Eighteen directors were elected, as follows:

*California and Pacific Coast:* J. A. Crawford, Republic Supply Company, Los Angeles; W. A. Trout, Emsco Derrick and Equipment Company, Los Angeles; C. S. Dulin, Byron-Jackson Company, Los Angeles; Lester Keim, Oil Well Supply Company, Los Angeles, and David Faulkner, Union Tool Company, Los Angeles.

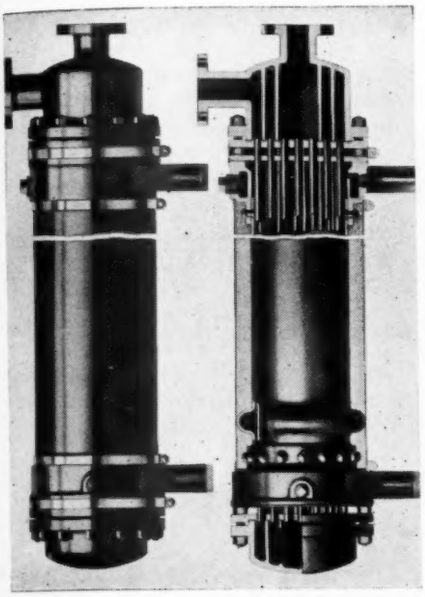
*Midcontinent:* W. J. Morris, Continental Supply Company, Dallas; Jack Shakley, Frick-Reid Supply Company, Tulsa; Earl Miller, American Iron Works, Oklahoma City; Frank Bernsen, Lucey Products Corporation, Tulsa; A. A. Buschow, Bridgeport Machine & Supply Company, Wichita, Kan., and A. A. Moody, Jarecki Manufacturing Company, St. Louis.

*Eastern:* J. A. Geismar, National Supply Company, Toledo; H. J. Lockhart, Parkersburg Rig and Reel Company, Parkersburg, W. Va.; Ben Harris, Oil Well Supply Company, Pittsburgh, and Percy C. Jones, S. M. Jones Company, Toledo.

*Gulf Coast:* John T. Crotty, Republic Supply Company, Houston; T. T. Word, T. T. Word Supply Company, Houston; Stanley P. Brown, Hughes Tool Company, Houston; Frank S. Carothers, Norvel-Wilder Supply Company, Houston, and B. Boykin, International-Stacey Company, Beaumont.

## Outside Joint Oil Heater

An eight-pass tubular outside joint oil heater is now offered the trade by the Coen Company of Los Angeles, San Francisco, Houston and New York City. The manufacturers claim that



with this outside joint heater it is impossible for a leaky tube joint to permit oil entering the steam space to find its way into the boiler, hot well or cooling tower. The tube sheets are of rolled steel, two tube sheets at each end, with a space between them open to the air. Thus, any oil leak or steam leak will drain to the atmosphere.

In addition to the outside joint feature, an expansion joint is built into the shell to relieve expansion strains. With the tube arrangement, the cold oil goes through the center tubes and is gradually heated as it approaches the outer row nearest the casing, which is at steam temperature. With this arrangement of oil passage there is no great pressure drop to cause a short circuit or leak from one pass to the other.

In operation, steam is admitted to a cored annular passage at either end of the shell. From this passage it is distributed into the heater shell through a row of holes on inner circumference. There is a steam connection at either end of the heater and drain connections at four points, two at each end. The heater may be used as a cooler by reversing the oil flow through the heater and circulating cold water through the steam space. Hot oil may be rapidly cooled in this manner from any temperature. Coen outside joint oil heaters are adaptable to either vertical or horizontal installations, and may be connected in any multiple combination.

## Safety Switch

The Electric Conrtoller and Manufacturing Company, 2696 East 79th Street, Cleveland, Ohio, has announced a new Type "A" Safety Switch. Although designed for severe duty, these switches are of extremely compact construction; the overall dimensions are small, nothing projects beyond the width of the box and the cover swings vertically, all of which permits minimum mounting space.

The switches are quick-make and quick-break-double-break, semi-floating V-blades (movable contacts) engage and open rapidly; they cannot be

partially opened or partially closed. Steel back-up springs on the V-stationary-contacts guarantee full contact under heavy pressures. The fuse door of these switches is interlocked with the operating handle so that raising the door trips the switch and the fuses cannot be reached except when the switch is open.

The switch mechanism is assembled on a single base that is held in the box by four screws. This permits easy removal of the entire mechanism as a unit for inspection, replacement of parts, or substitution of a new switch.

These safety switches are convertible from larger to smaller sizes by simply changing fuse clips and moving fuse block to the proper threaded holes supplied in all boxes.

## Drop-Forged Pipe Couplings

The Champion Drop Forged Pipe Coupling, manufactured by the Champion Machine and Forging Company and distributed by the Continental Supply Company, St. Louis, Mo., is made for both plain end and grooved pipe.

The Champion Plain End Pipe Coupler was developed to facilitate the laying of pipe lines by the use of straight plain-end pipe that has not been subjected to an extra finishing operation, such as grooving or upsetting the ends, and still provide in tension sufficient to meet all the strains encountered during the laying of the line, and also while the line is under pressure.

These couplings consist of five distinct sections or parts, viz., two half couplings that contain the gripping device, one gasket with metal protected sections and two bolts. The couplings are drop forged of a special grade of steel to produce a strong and light coupling. The gripping rings are drop-forged and heat-treated to produce a hard and tough section, and are assembled into the half couplings in such a manner as to become integral with the coupling itself so there is no danger of their being lost. The bolts are especially treated to provide an extremely high elastic limit but retaining a sufficient degree of elasticity to prevent any breakage. The gaskets are designed along the lines of the low pressure automobile tire with a double seal that is equally effective against either pressure or vacuum. Tests have shown that the rubber seal is effective up to pressures of 4000 lb. per sq. inch.

## Imperial No. 80-SC Oilbath Geared Power

A COMPACT, fully enclosed, oilbath geared power for pumping a number of deep wells has been designed by the Oil Well Supply Company, Dallas, Texas. Its horsepower input capacity is conservatively rated for oil field service at 80 hp. at 20 s.p.m. or 115 hp. at 30 s.p.m.

The Imperial No. 80-SC is the stationary-spindle type. The crank and main gear revolve as a unit around the spindle, which is cast integral with the well-reinforced semi-steel base; and the thrust is transmitted directly to the base. This design permits a wide bearing spacing, for properly supporting the overhung crank, with a minimum overall height. The pull-rod connections are close to the foundation.

The double-reduction gears are the same as those that have proved so highly satisfactory in the No. 80 (Eccentric Type) powers and are properly heat-treated for maximum wear-resistance and strength.

The cast-steel crank is of the exclusive "Oilwell" dual-stroke type with two crank pin holes. The crank pin is placed in one for a 30-in. stroke and the other for a 36-in. stroke. The pull-rod strap disc has 16 clevis holes, each provided with a hardened steel bushing. The clevis pins are drilled for Alemite lubrication.

The Imperial No. 80-SC power can be driven by a gas, gasoline or oil engine or by an electric motor. Installation drawings and detailed information will be furnished on request to the nearest Oilwell representative.

## Orifice Meter Peep Flange

THE REFINERY SUPPLY COMPANY, 621 East Fourth Street, Tulsa, Okla., has developed a new orifice peep flange for orifice meters. It is a simple pipe flange for holding an orifice plate. The feature of the flange is that the orifice plate may be inspected at any time without touching the flange or removing the plate.

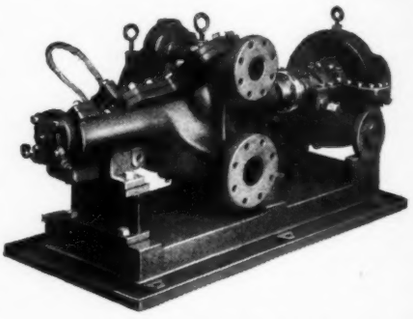
The R. S. Orifice Peep Flange is constructed along the lines of a simple high-pressure orifice flange. It is built to hold an orifice plate and is properly tapped for the up-stream and down-stream pressure connections. Two lenses are built in the flange directly opposite each other at the proper angle, so that they are both directed on the orifice plate. One of these lenses brings light into the flange, while the other offers a direct view of the plate for inspection.

## Goulds Hot Oil Pump

GOULDS PUMPS, INC., Seneca Falls, N.Y., announce the addition of a new single-stage centrifugal hot oil pump to their line of pumps for the oil industry. Built in four sizes, for handling capacities up to 500 g.p.m., adequate provision has been made in the design for efficient operation under the severe service encountered in modern refinery practice.

The casing is split at a 45-deg. angle which allows self-venting top discharge and, at the same time, gives the usual ready accessibility for inspection of impeller and wearing rings. For temperatures up to 450 deg. fahr., cast iron casing is furnished; while for temperatures up to 1000 deg. fahr., electric carbon steel or alloy steel casing is used, depending on requirements of service. The suction chamber is vented, and stuffing box and bearing are water-cooled. The shaft is furnished with sleeves of nitrated nitralloy.

The pump is rigidly secured to bedplate at coupling end so that expansion, due to temperature changes, is away from the driving end. The steel web

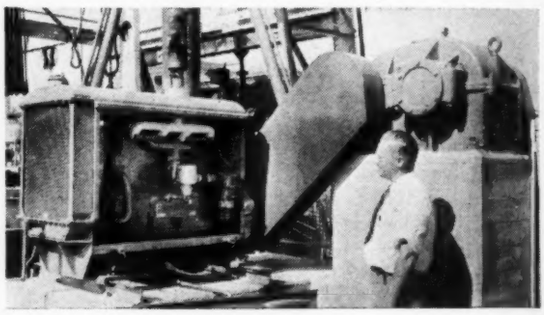


support, at the outboard end at right angles to shaft, flexes with the expansion of the pump; but at the same time maintains a rigid alignment of the shaft in a horizontal pane.

Complete information on these new pumps will be gladly furnished upon request to the manufacturer.

## Enterprise SG-40 Natural Gas Engine

THE NEW ENTERPRISE SG-40 Natural Gas Engine has been designed and built especially for pumping oil wells. The installation shown is driving, through a V-belt drive, a No. 5FO Pacific Herringbone Reduction Gear unit on which a Marsh Counterbalance Crank is mounted. The engine is equipped with a Pacific Spherical Bearing Pitman and is operating 6200 ft. of ¾-in. sucker rods at 24 44-in. strokes per minute, the pump having a 1½-in. net diameter plunger. From 180 to 200 bbl. of oil are being pumped daily from the well.



The engine is a heavy, rugged power unit that will give long, continuous service at minimum cost of operation and upkeep. It is a 4-cylinder, 4-cycle, valve-in-head type embodying special designed features which meet the exacting requirements of oil field service.

The engine is of the marine type in design. It has no removable crankcase, as all reciprocating parts are readily accessible through two large side doors, which permits complete overhauling without removal of the engine from its foundation. All wearing parts are made of materials selected for long, continuous service, but are interchangeable and may be completely replaced in the main engine casting. An extra large flywheel and heavy power take-off assists in smoothness of operation.

Highly effective cooling is accomplished by a large water-jacketed area, a water pump of generous capacity, radiator and fan draft; so that uniform and efficient working temperatures are maintained in the hottest climate.

Application of the Enterprise SG-40 Engine depends on the equipment already available at the well. Further information regarding the unit and its adaptability to any specific purpose may be obtained from the Rotating Pumper Company, 1333 Santa Fe Avenue, Los Angeles, Calif., exclusive distributors in the petroleum industry.

# LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

## Young Ones

"Hello, old man! How you've changed! What's making you look so old?"

"Trying to keep young," was the reply.

"Trying to keep young?"

"Yes—nine of them," was the gloomy response.

* * *

*Johnny:* Better watch your step, gus, that girl you've started going with is a smart little gold-digger.

*Gus:* She may be a smart gold-digger, but she's a poor geologist.

* * *

*Movie Actress:* I'll endorse your cigarettes for $50,000.

*Executive:* I'll see you inhale first.

* * *

*Wife:* Of course women are as capable as men. Why, I know a girl of twenty-two who gets the salary of a sales manager in a big business house.

*Husband:* I don't doubt it, my dear. When did she marry him?—*Pathfinder.*

* * *

*Teacher:* Johnny, I'm surprised! Do you know any more jokes like that?

*Johnny:* Yes, teacher.

*Teacher:* Well, stay after school.

* * *

## What the Heck?

"Say, Mr. Buck, do they have oil wells in heaven?"

"No, son," replied Buck, "It takes drillers to make oil wells."—*Pure Oil News.*

* * *

*Lawyer:* Was your car under complete control at the time?

*Defendant:* Yes, my wife was sitting in the rear seat.

* * *

*Tillie:* That deaf and dumb fellow I was out with last night carries on a fast conversation with his hands. Has he ever talked to you that way?

*Tilda:* Has he? Say, the last time I was out with him he almost talked a leg off of me.

* * *

"Was Aubrey mad when he tried to get away from that skunk?"

"Not mad—but he was terribly incensed."

* * *

"So the doctor's trial marriage has been found out?"

"Yes, and he's been arrested!"

"Arrested! What's the charge?"

"Practicing without a license."

* * *

An old negro preacher was explaining to his congregation the difference between faith and knowledge.

"No, my bredren," he said, "hit's like dis: Dar's Brudder Johnsing a-sittin' on de front seat wid Sister Johnsing, and de five little Johnsings. She knows dey's her chillen—dat's knowledge. He believes dey's his children—dat's faith."

—*Printers' Ink.*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Star Insert
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*Rocky Mountain Distributor:*

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# Solving Well-Pumping Equipment Problems

## Article V

By HYMAN LEEDEN
Engineer-in-Charge, Western Division,
The Falk Corporation, Milwaukee, Wis.

### Ratings and Selections

TO insure long life and satisfactory operation of pumping equipment it is important that the load ratings placed upon them be rational and conservative. Since wells differ from several hundred to 10,000 ft. in depth, and from 10 to 1000 bbl. per day in production, it is necessary to build more than one size of unit to meet the various load requirements. Therefore some method of rating must be adopted that strikes a balance between capacity and economy.

There has been some effort in the past to rate pumping units by speed and hp., or by torque, in the same manner as conveyor drives are rated, but such efforts have been unsuccessful. There are differences between conveyors and oilwell pumping drives that are bound to affect the methods of rating. In the conveyor the load, the distance to be moved, the friction losses, and the motor characteristics are fairly well known in advance. The speed of the conveyor will probably be uniform throughout its life; the amount of material that it can carry is limited by its size; the maximum required hp. is a function of weight and speed; the friction losses can be estimated with reasonable accuracy; the peaks to be encountered are mostly for starting, and will not be more than double the normal load. The gear manufacturer provides a unit with a definite ratio that will reduce motor r.p.m. to conveyor r.p.m., and will transmit safely the torque incident to such hp. and speed.

In an oil well, however, the number of variables and uncertainties makes the calculation of load an exceedingly difficult and risky subject. It cannot be determined with any degree of certainty just how much weight will have to be lifted, nor what the elevation will be; what friction will be encountered, nor what the prime mover will be during the life of the well. Neither the operators of the oil companies, nor the manufacturers of equipment are in sufficient agreement as to the coefficients and constants for estimating the actual loads to be moved. The loads themselves are highly fluctuating in nature, varying from well to well of the same description, and almost from month to month on the same well. The prime movers used may be of any type, construction or performance, and the size selected may or may not be in harmony with the load, even if computed. Given the same specifications for a well to be pumped, the operators of several oil companies will get different answers as to the speed and power required; nor will the equipment manufacturers be in better agreement. When the statement is made that a given hp. will be used, it is not at all certain whether that is the maximum, the minimum or the normal hp.; nor is it known whether the peaks will be twice or three times the normal. It is possible, however, to list the major variables about an oil well, to base ratings on known well conditions, and thus to obtain reasonable safety combined with rational selection and low initial cost.

Except where a well is completely sanded up, or where some similar unusual event has occurred, the loads that the pumping unit must stand come, not from the motor, but from the well. Where a gas engine is used, certain additional shocks are encountered, which, however, may be met by suitable flywheels, V-belts, or larger dimensions. Where a motor is used, regardles of type, style or size, the load on the transmission will not be affected so long as well conditions do not change. The peaks that will be encountered will be peaks from the well that the motor is trying to meet, not peaks from the motor that the well is trying to receive. To arrive at a rational method of rating pumping units, it is necessary to list the technical loading conditions, and the extent to which variations may be expected. If all the variables encountered are listed, certain reasonable assumptions can be agreed upon, and ratings made accordingly.

**Depth of Pumping.** When the well ceases to flow and pumping is begun, the fluid level may be fairly high; the reservoir energy helps lift the fluid and the pump need not be placed much below the surface of the well, regardless of the depth of oil sand. However, as the reservoir energy inevitably drops, the fluid level recedes, and the pump must be lowered until it is ultimately set at or very near the bottom of the well. As the equipment is expected to last the life of the well, it should be rated, selected and purchased for the full depth, not for the depth of temporary submergence.

**Weight of Material.** The A.P.I. or Baumé gravity of the oil produced varies from well to well, and in the same well from period to period, when the well is new, it may have much gas, and the oil will have a low specific gravity. As the well gets older, some of the gas will escape or water may intrude, making the fluid heavier. A fair average for rating and computation purposes is a gravity of 30 deg. A.P.I., or about 55 lb per cu. ft. of fluid. Capacities of equipment based on this gravity will meet most oilfield conditions; capacities may, however, be modified for other gravity conditions, if known definitely.

Most wells will produce fluids of lighter weight than given in Table 36, but these figures offer a convenient and fairly safe basis for rating. For heavier fluids, the weights given may be multiplied by the ratio of the specific gravity to .875. However, the loads will be increased more than this ratio due to greater fluid friction. To allow for this difference in friction, this ratio is squared and the factors shown in Table 37 are used for different gravities only.

**Rods.** The weight of rods, taking into account the fit-

**TABLE 36**
**Weight of 30-deg. A.P.I. gravity oil per 1000 ft. for various pumps**

| Size of Tubing | Size of Pump | Size of Plunger | Size of Rods | Weight of oil per 1000 ft. |
|---|---|---|---|---|
| | | LINER PUMPS | | |
| 2 -in. | 2 -in. | 1¾-in. | ⅝-in. | 790 lb. |
| 2 -in. | 2 -in. | 1¾-in. | ¾-in. | 750 lb. |
| 2½-in. | 2½-in. | 2¼-in. | ¾-in. | 1360 lb. |
| 3 -in. | 3 -in. | 2¾-in. | ¾-in. | 2090 lb. |
| 4 -in. | 4 -in. | 3¾-in. | ⅞-in. | 4000 lb. |
| | | INSERT PUMPS | | |
| 2 -in. | 2 -in. | 1½-in. | ⅝-in. | 560 lb. |
| 2 -in. | 2 -in. | 1½-in. | ¾-in. | 510 lb. |
| 2½-in. | 2½-in. | 1⅝-in. | ¾-in. | 790 lb. |
| 2½-in. | 2½-in. | 1⅝-in. | ¾-in. | 960 lb. |
| 3 -in. | 3 -in. | 2¼-in. | ¾-in. | 1360 lb. |
| 3 -in. | 3 -in. | 2⅝-in. | ¾-in. | 1600 lb. |

tings, are given in Table 38. Of all the loads on an oil well the weight of the rods is probably the most certain. It may decrease as the rods are attacked by acids and corroded, but not to any appreciable amount.

**Pumps.** As the size of the pump may be changed during the life of the well, the rating of the unit should be based on the maximum size likely to be used. Since production at the present time is limited to rather small volumes, the size of the pump can be decided on in advance, so as to get the maximum volumetric efficiency. Based upon this size, loads may be estimated and ratings set. However, individual ratings may be set for each size of pump.

**Stroke.** The length of the stroke should be taken as the maximum that the crank is capable of producing. Where a crank has several holes for, say, 24-in., 34-in. and 44-in. stroke, the operators may feel that 34-in. is all that will ever be used; but as operating staffs change, or as additional experience is obtained with the economies of long-stroke pumping, the pin may be moved out to the last hole, and the 44-in. stroke used.

A.P.I. stroke lengths for 6-in. rig irons are 24-in., 34-in., 44-in., 54-in., 64-in. and 74-in. Individual ratings may be set for each of these lengths.

**Pumping Speeds.** While the weight of the oil and the rods can be ascertained or assumed with reasonable accuracy, the size of the pumps can be predetermined and fixed, and the length of the stroke can be limited by the construction of the crank. The speed of the pump must be left flexible and within control of the operator. A V-belt drive is introduced for the specific purpose of permitting speed changes without undue effort and expense.

At other than the lowest speeds, the acceleration and deceleration of moving masses impose additional loads that may have the same effect as more fluid or more friction. Table 39 shows empirical constants used in modifying the weights of oil for the effect of acceleration. A speed of 16 s.p.m. is taken as an arbitrary standard, with a factor of 1.000, because it represents a medium between the slow speed, 7½ s.p.m., and the maximum of 30 s.p.m.; the values for speeds higher and lower than 16 s.p.m. are based on experience gained from dynamometer and recording watt-meter charts taken from many wells in the various fields.

**Counterbalance.** The total weight of the material to be lifted is that of the rods plus the oil. If the well is counterbalanced properly, the weight to be lifted, except for friction, will be that of half the oil only. If the well is not balanced at all, it will be equal to the weight of the rods plus the weight of the oil. A common belief is that the well is properly balanced when the rods and counterweight are equal; yet in such a case only the rods are balanced; the oil is not balanced at all.

**TABLE 37**
**Gravity factors for modifying weight of oil**

| A.P.I. Gravity | Specific Gravity | Gravity Load Factor | A.P.I. Gravity | Specific Gravity | Gravity Load Factor |
|---|---|---|---|---|---|
| 10 | 1.000 | 1.306 | 30 | .875 | 1.000 |
| 11 | .993 | 1.288 | 31 | .870 | .988 |
| 12 | .986 | 1.270 | 32 | .864 | .975 |
| 13 | .979 | 1.252 | 33 | .859 | .964 |
| 14 | .972 | 1.235 | 34 | .854 | .952 |
| 15 | .966 | 1.218 | 35 | .848 | .940 |
| 16 | .959 | 1.201 | 36 | .843 | .929 |
| 17 | .952 | 1.185 | 37 | .838 | .918 |
| 18 | .946 | 1.169 | 38 | .833 | .907 |
| 19 | .940 | 1.153 | 39 | .828 | .896 |
| 20 | .933 | 1.138 | 40 | .824 | .886 |
| 21 | .927 | 1.123 | 41 | .819 | .875 |
| 22 | .921 | 1.108 | 42 | .814 | .865 |
| 23 | .915 | 1.094 | 43 | .809 | .855 |
| 24 | .909 | 1.079 | 44 | .805 | .846 |
| 25 | .903 | 1.066 | 45 | .800 | .836 |
| 26 | .897 | 1.052 | 46 | .795 | .826 |
| 27 | .892 | 1.039 | 47 | .791 | .817 |
| 28 | .886 | 1.025 | 48 | .787 | .808 |
| 29 | .881 | 1.013 | 49 | .782 | .799 |
| | | | 50 | .778 | .790 |

**TABLE 38**
**Weight of rods per 1000 ft.**

| Size of rods | Weight per 1000 ft. |
|---|---|
| ⅝-in. | 1150 lb. |
| ¾-in. | 1690 lb. |
| ⅞-in. | 2270 lb. |

**TABLE 39**
**Acceleration factors for modifying weight of oil**

| Pumping Speed in s.p.m. | Accelleration Load Factor | Pumping Speed in s.p.m. | Accelleration Load Factor |
|---|---|---|---|
| 1 | .837 | 16 | 1.000 |
| 2 | .839 | 17 | 1.019 |
| 3 | .844 | 18 | 1.041 |
| 4 | .849 | 19 | 1.064 |
| 5 | .855 | 20 | 1.088 |
| 6 | .862 | 21 | 1.113 |
| 7 | .871 | 22 | 1.142 |
| 8 | .881 | 23 | 1.175 |
| 9 | .892 | 24 | 1.211 |
| 10 | .903 | 25 | 1.250 |
| 11 | .915 | 26 | 1.293 |
| 12 | .929 | 27 | 1.340 |
| 13 | .944 | 28 | 1.388 |
| 14 | .960 | 29 | 1.440 |
| 15 | .978 | 30 | 1.500 |

Even if a well is correctly balanced, changing gas conditions, the influx of water, or even a change in weather might make it unbalanced. Even if conditions do not change, the well may operate some time during its life, even if only for a few days, without any balance at all. The counterbalance is, therefore, one of the greatest items of uncertainty in the loading of a well.

The conditions shown in Table 40 are possible and should be anticipated. From this table it is apparent, immediately, that peak loads to be anticipated in a well and caused by variations in counterbalance alone may range from 3.66 to 8.62 times the ideal condition, but with one exception the load may be considered as limited to three times the ideal.

Table 41 gives the modifying factors for possible unbalance. Where the ratio of the unbalanced load to the actual load is 3 to 1 or less, the modifying factor is 1. Where the ratio is greater than 3 to 1, the factor is one-third the ratio.

Rational rating would dictate that equipment should:

(1) Advocate balancing so that the load will be the same on upstroke and the downstroke, or approximately equal to the rods plus half the weight of the oil, but should not assume that it will always be done.

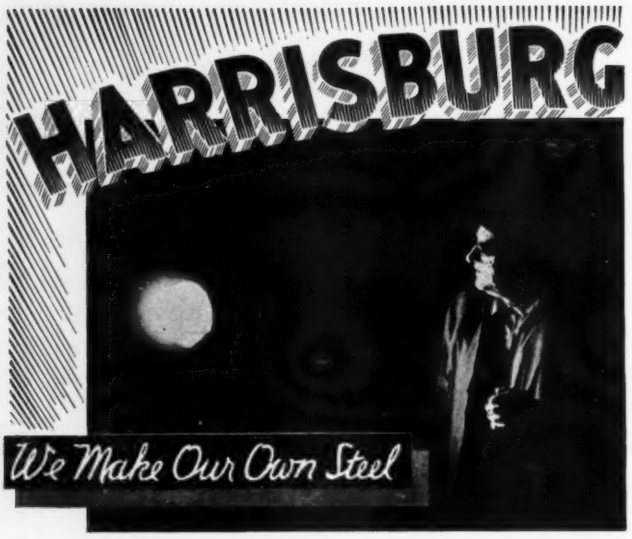
(2) Operate continuously and satisfactorily with a load equal to that of only the rods balanced. This is twice the ideal, and equals the weight of oil.

(3) Have sufficient strength to operate for short periods, with no counterbalance at all.

There is no escape from proper provisions for these conditions. They must be expected and anticipated on every well.

**Indeterminate Variables.** On the previous items it has been possible to compute or assign values to variations in depth, gravity, pump, stroke, speed and counterbalance. There are, however, two other sources of peak loads that may have to be handled by the pumping equipment, and seem practically impossible to estimate. One is the imposition of shocks due to loose wrist pins, center irons, etc.; this may easily double the ordinary loads. The other is the increase of load due to clogging of tubing by paraffin or sand; this may run many times the normal load.

It does not seem rational or economical to ask for equipment that will stand each and every one of the loads and variations enumerated, because only in the rarest cases will all the loads be encountered simultaneously. However, equipment should be rated to carry a reasonable combination of these elements.

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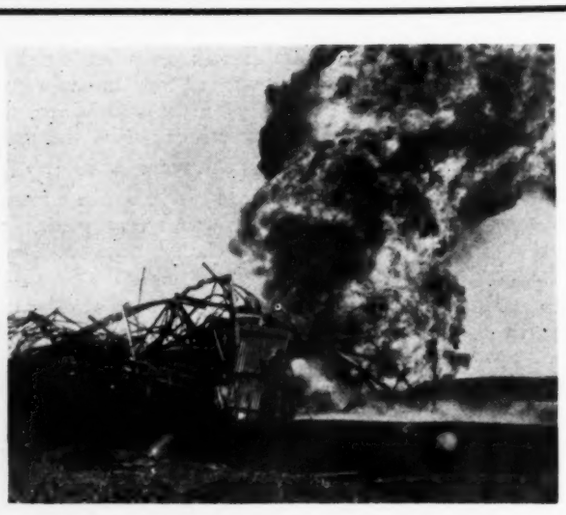

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**TABLE 40**
**Possible increase in load due to unbalance**

| Type of Pump | Size Plunger in inches | Size Rods in inches | Weight to be lifted by power 1000-ft. well | | | Load Ratio | |
|---|---|---|---|---|---|---|---|
| | | | **Ideal** Rods plus half oil balanced | **Actual** Rods only balanced | **Unbalanced** No balance at all | Unbalanced to Ideal | Unbalanced to Actual |
| Liner | 1¾ | ⅝ | 395 | 790 | 1940 | 5.25 | 2.62 |
| | 1¾ | ¾ | 375 | 750 | 2440 | 7.65 | 3.25 |
| | 2¼ | ¾ | 680 | 1360 | 3050 | 4.48 | 2.24 |
| | 2¾ | ¾ | 1020 | 2040 | 3730 | 3.66 | 1.83 |
| | 2¾ | ⅞ | 1045 | 2090 | 4360 | 4.16 | 2.06 |
| Insert | 1½ | ⅝ | 280 | 560 | 1710 | 6.12 | 3.06 |
| | 1½ | ¾ | 255 | 510 | 2200 | 8.62 | 4.31 |
| | 1 25/32 | ¾ | 395 | 790 | 2480 | 6.28 | 3.14 |
| | 1 15/16 | ¾ | 480 | 960 | 2690 | 5.41 | 2.70 |
| | 2¼ | ¾ | 680 | 1360 | 3050 | 4.48 | 2.24 |
| | 2⅝ | ¾ | 800 | 1600 | 3290 | 4.11 | 2.05 |
| | 2⅝ | ⅞ | 775 | 1550 | 3820 | 4.94 | 2.47 |

## Loads on Equipment Imposed by the Well

The combinations of loads to be considered and provided for may be classified as Ideal, Actual, Unbalanced, Limit and Rare.

**Ideal Load.** A perfectly counterbalanced well (rods plus half the oil), operating at slow speed, with little or no friction in the well. This condition is often advocated, frequently approached, and sometimes realized. It is not a proper basis for rating purposes.

Load = ½ the weight of oil, modified for gravity and speed.

**Actual Load.** A well counterbalanced with some inaccuracy, having some internal friction loads, and subjected to certain acceleration loads. One illustration was figured as follows: "Ideal" load × 1.33 (for counterbalance error) × 1.20 (for friction and acceleration) × 1.10 (for gear and V-belt losses) × 1.10 (for miscellaneous) = 1.94. This condition is not advocated, but is frequently encountered. It is a proper and satisfactory basis for rating for continuous operation. Equipment on such a well should be able to function continuously, without trouble.

Load = twice the "Ideal" = wt, of oil, modified for gravity, speed and counterbalance.

**Unbalanced Load.** A well on which all the counterbalance has been intentionally or unintentionally omitted, and in which some friction and acceleration loads are to be found. This condition is not advocated, but is encountered at some time for a short period on almost every well, and for long periods on some wells. It is not a fair or usual basis for normal rating, but it is a most desirable basis for peak-load rating. Equipment need not be expected to operate continuously under such conditions, but it should be able to stand them for short periods.

Peak loads due to counterbalance variations alone are found to range from two to three times the "actual" condition, and from four to six times the "Ideal" condition. To these must be added friction and acceleration. For the sake of uniformity, it seems best to assume that the "Unbalanced" load (due to counterbalance, friction and acceleration) will be three times the "Actual" and six times the "Ideal" condition. This, it must be recognized, is only a fair average, but it gives a rational basis of rating and guarantee.

Load = 6 × "Ideal" = 3 × weight of oil (in most cases) modified also for gravity and speed.

**Limit Load.** To make sure that the equipment will be able to carry safely the "Unbalanced" loads guaranteed, the manufacturers must necessarily build in an additional reserve factor. This additional reserve is the ratio between elastic limit of the materials and the maximum safe stress that is guaranteed. In some pumping units this is about 3 to 1, and is not at all excessive, as it forms a usual basis for rating speed reducers on industrial applications.

The reserve that is built into the pumping unit will carry, though without guarantee, additional peak loads equal to about three times the "Unbalanced," ten times the "Actual," or 20 times the "Ideal" loads. Protection for such conditions should be provided in the form of limited motor capacity, shear pins, weak chains, fuses or instant-acting electrical cut-outs.

Load = 10 × weight of oil, modified for gravity, speed and counterbalance = elastic limit of materials.

**Rare Load.** A unit rated for the "Actual" load, guaranteed for the "Unbalanced" load and equal to the "Limit" load, is not yet equal to all that may happen to it. It is possible to get a rare load consisting of total unbalance, excessive looseness and misalignment, high speed, crooked hole, heavy sand or paraffin condition, and unusual water encroachment. Such conditions are rare, but they may be met. However, they do not form a proper basis for rating under any consideration, and equipment need not be built to stand them.

Load = more than 10 × weight of oil.

Under this condition the load could not be carried by the unit.

## Stresses on Equipment Due to Loads Imposed by the Well

The stresses imposed upon pumping equipment are entirely functions of these loads. The power required to pump the oil will depend upon these loads and upon the efficiency of the equipment used. When the loads and the efficiencies are ascertained, the setting of ratings becomes a relatively simple matter. The usual arrangement includes the sucker rod, walking beam, sampson post, pitman, counterbalance, wrist pin, crank, gear unit, V-belt and prime mover. For such equipment the following considerations apply.

**Crank Pull.** The various loads enumerated all act on the crank through the wrist pin. They try to force the wrist pin out of the crank, to bend or break the crank shaft (low-speed shaft) in the gear unit, and to overload and ruin the low-speed bearing. It may properly be termed *crank pull*, because it tries to pull the crank in two. It is totally independent of the length of stroke, or the number of strokes per minute. The principal stresses produced by this crank pull in a gear unit may be computed by the usual methods, assuming that the low-speed shaft acts as a cantilever beam, fixed at some point in the bearings, and loaded at the wrist pin. Referring to Fig. 7 showing the location of load for computing stresses in gear units:

$$F = Wa/Z = Wa/.098\ d^3 \qquad (5)$$

where $F$ = bending stress in lb. per sq. inch
$A$ = amount of beam overhang (see Fig. 7) in inches
$Z$ = section modulus in bending = $.098\ d^3$
$d$ = diameter of shaft in inches
$W$ = crank pull in lb. = $WoCgCaCc$

where $Wo$ = weight of oil in pounds
$Cg$ = gravity modifying factor, Table 37
$Ca$ = speed modifying factor, Table 38
$Cc$ = counterbalance modifying factor, Table 41

The bearing pressure on the crank bearing may be computed by the usual method of moments, or may be approximated with sufficient accuracy for practical purposes by disregarding moments and assuming the load as concentrated directly on the crank bearing.

**TABLE 41**

**Counterbalance factors for modifying weight of oil**

| Size of Pump | Size of Plunger | Size of Rods | Ratio of Unbalanced to Actual Load | Counterbalance Load Factor |
|---|---|---|---|---|
| 2-in. | 1½-in. | ⅝-in. | 6.2 | 3.07 |
| 2-in. | 1¼-in. | ¾-in. | 10.9 | 3.63 |
| 2-in. | 1¼-in. | ⅝-in. | 3.06 | 1.02 |
| 2-in. | 1¼-in. | ¾-in. | 4.31 | 1.44 |
| 2-in. | 1¾-in. | ¾-in. | 3.25 | 1.08 |
| 2½-in., 3-in., 4-in. | All sizes | | 3 or less | 1.00 |

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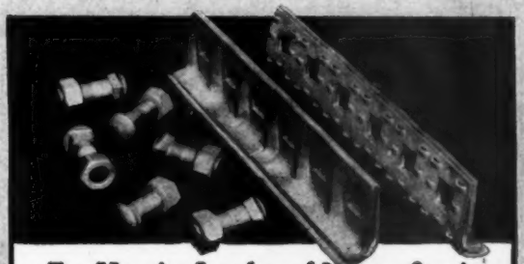

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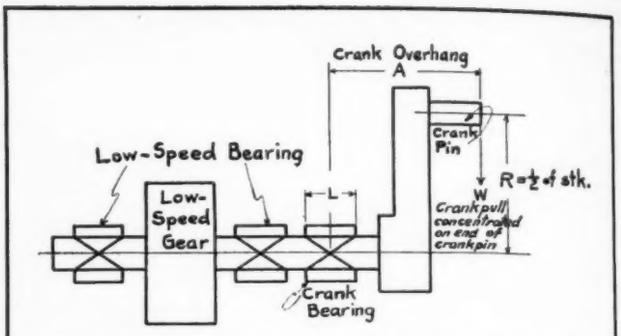


Fig. 7. Location of load for computing stresses in gear units

$$Pb = W/1d$$

where $Pb$ = bearing pressure in lb. per sq in.
$W$ = crank pull in pounds
$1$ = length of bearing
$d$ = diameter of bearing

The *crank pull* rating given to a gear unit must, therefore, be such that the bending stresses provided by the "Actual" load will be 1/10 of the elastic limit, and such that the bearing pressure will be less than 1/10 of the bearing capacity.

**Torque.** At the instant that the crank pin is exactly above or exactly below the center of the crank, the only load on the low-speed shaft is the bearing load, and the only stress is the bending stress. As the crank pin rotates, however, the eccentric location of the crank pin with respect to the crank produces a twisting moment that is the product of the crank pull and the eccentricity, until a point is reached twice in each revolution where the torque is equal to the crank pull times the crank arm, or:

$$T = Wr$$

since r is one-half the stroke S

$$T = WS/2 \text{ maximum and } 0 \text{ minimum}$$

where $T$ = torque in pounds
$W$ = crank pull in pounds
$S$ = length of sucker rod stroke in inches
$Tav$ = average torque of each cycle
$= T \times 2/\pi = T/1.57$

This torque depends on both the crank pull and the stroke; but it is independent of the number of strokes per minute.

The torsional stress in the low-speed shaft,

$$F = T/.196\ d^3 \text{ maximum and } 0 \text{ minimum}$$

Since the maximum stress occurs twice in each revolution, it must be assumed as a continuous stress for all rating purposes.

The torque rating given to a gear unit must, therefore, be such that the torsional stresses produced by the "Actual" load will be 1/10 of the torsional elastic limit. Obviously, also, all other parts of the gear unit must have at least this strength.

**Horsepower.** Both crank pull and torque are static loads; they depend on weight and position. The movement of loads from position to position introduces the dynamic factors, work and power. Work is the product of weight and distance. Power is the rate of doing work. Crank pull depends only on the weight of the oil (and its various ratios and modifying factors); torque depends on both the weight of the oil and the stroke; the hp. depends alone on the weight of the oil and the length of the stroke, but also on the pumping speed in strokes per minute. Crank pull and torque, being static loads, are not affected by the efficiency of the surface equipment. The hp. input of the motor or engine must lift the oil and overcome the frictional losses of the pumping equipment; it is vitally affected by efficiency. The hp. delivered to the sucker rod is not dependent on this efficiency, but depends on the loads in the well.

Crank pull $W$ = weight of oil, modified by factors (1)

Torque $T$ = Crank pull ($W$) × ½ stroke ($S/2$) (2)

Horsepower $HP$ = Torque ($T$) × strokes per min. ($N$)

$= WSN/126{,}000.$ (3)

Since the torque varies from zero to maximum, the hp. will likewise vary from zero at the ends of the stroke to maximum at about the midpoints.

The average hp. delivered to the sucker rod may be computed by the usual methods.

$$HP = (W \times S/12 \times 2N)/\ 33{,}000 \quad (4)$$

where $W$ = crank pull in pounds

$S$ = length of sucker rod stroke in inches

$N$ = number of strokes per minute

$T$ = peak torque in in. lb.

The relation between peak torque and average torque, or between peak hp. and average hp. is that occasioned by converting the rotating action of the crank to the reciprocating action of the sucker rod, and $198{,}000/126{,}000 = 1.57 = \pi/2$.

As in the case of torque, the peak hp. comes on twice in each revolution, and must be assumed as the continuous load for rating purposes. At one stroke per minute, these become

Average hp. to sucker rod $= WS/200{,}000 = T/100{,}000$ per s.p.m. $= Tav/63{,}000$ (7)

Peak hp. to sucker rod $= 1.57 \times$ av. hp. $= T/63{,}000$ per s.p.m. (8)

These, it should be noted, are the hp. delivered to the sucker rod. The hp. delivered to the surface equipment will depend on the efficiency of the equipment.

The *hp. rating* given to a pumping unit should therefore state both the peak capacity and the average capacity per s.p.m. The *peak hp. capacity* must be such that throughout the pumping unit the elastic limit of each and every item stressed toward breakage (such as shafts, chains, gears, belts, keys, etc.), will be at least ten times the load produced by the rating. The *average hp. capacity* must be such that throughout the pumping unit (1) the elastic limit of each and every item stressed toward breakage will be at least 15.7 times the load produced by the rating and (2) each and every item stressed toward wear will have a wear factor sufficient to insure long life.

The rating based upon strength for belt-driven and for chain-driven rigs is relatively easy to compute; it is more difficult, but not impossible, to compute it even for gear teeth, whether of the spur, worm, helical or herringbone type.

The rating based upon wear is, however, a much more difficult item. Just what life will a bearing have or just how long will a gear tooth resist wear under a given load is frequently not a matter of computation, but of test and experiment.

Frequently elements entirely beyond the stress calculation determine the wear life. The amount and viscosity of the lubricant, the thickness or ribs below bearings, the accuracy of alignment, the uniformity of materials, the rigidity of the manufacturer's inspection—all contribute to slow or rapid wear.

Gear units are rated consistent with these principles:

1. For continuous operation—24 hours per day where the load does not exceed a value equal to twice the unbalanced weight of oil. At this condition the gears and bearing will run satisfactorily and will not show excessive wear.

2. For starting operation or other momentary peaks, such as running without any counterbalance, where the load does not exceed three times the continuous rating. At this condition the gears will run, but will wear rapidly.

3. Line of operation, where the load has for one reason or another been so increased as to reach the elastic limit of the materials at this condition, something is expected to break—usually the low-speed shaft. The ratio of limit operation to continuous operation is about 10 to 1.


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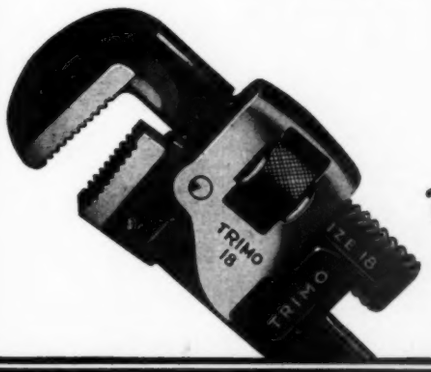


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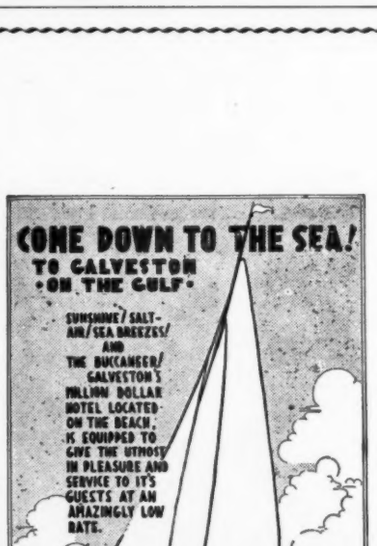
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# » » Preventing « « Hydrometer Breakage in Pipe Line Stations

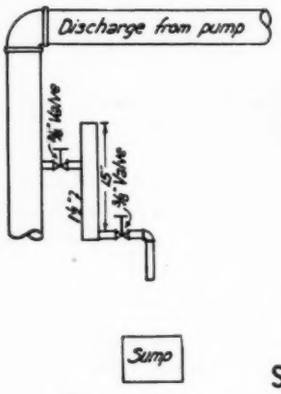


Fig. 1


By S. C. DILLMAN
Station Engineer
Sinclair-Prairie Pipe Line Company


A SIMPLE method to prevent excessive breakage of hydrometer thermometers when taking samples of crude oil in pipe line stations has been in use by the Sinclair-Prairie Pipe Line Company at a number of its stations for the past few years. In addition to preventing an undue amount of thermometer breakage, the method saves a great deal of work by its simplicity and also aids in stopping the accumulations of waste oil that so frequently occur when this work is being done.

The hydrometer is placed in a 1½-in. nipple that is 15 in. long more or less, as conditions require. Since some operators use short instruments and others use long-range hydrometers the length of this nipple cannot be made standard. In use the hydrometer need never be taken from the device, the construction and method of using which is best explained by means of the accompanying sketch, see Fig. 1. The nipple is connected to the discharge from the pump by a ⅜-in. pipe, in which a valve is inserted. When valve 1 is opened, the oil flows into nipple 2 from discharge line 5. As the oil level rises in nipple 2, the hydrometer rises and when nipple 2 is full a correct reading can be taken. By opening valve 3, after reading sample, the oil is permitted to flow from nipple 2, to sump barrel 4, after which the device is ready for the next sample.


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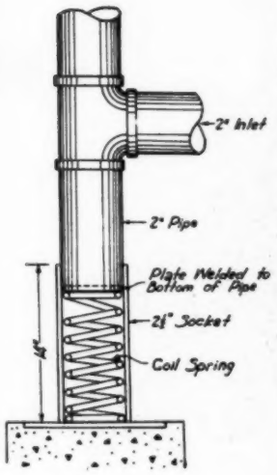
# Expansion Anchor for Pipe

By M. C. COCKSHOTT
Design Engineer




TALL vessels of narrow diameter such as fractionators or stills that are operated at high temperature undergo contraction and expansion, the resulting movements from which are transmitted to the pipes coming into the top of the vessel. A simple method of overcoming the damaging effects of these movements is by means of a spring expansion anchor.

This anchor is made by taking the inlet pipe and closing it by welding at the bottom end where it would normally be set in a base ell, the welded end being some eight or ten inches from the base. Arrangements for the line running into it are provided by a tee in the line as shown in the accompanying sketch. Assuming, as in the example shown, that the diameter of the inlet pipe is two inches, a socket 2½ in. in diameter and 14 in. long can be made up with a base plate welded into it. Inserted in the socket is a heavy coil spring 12 in. long and of a diameter that will permit free movement in the socket.

When installing the inlet pipe it is hauled into position and made fast at the top of the fractionator after the bottom end of the pipe has been inserted in the socket. After the pipe is lined up installation of the flexible anchor is completed by grouting the socket plate into place. Under the weight of the pipe the spring is compressed a certain amount and when the heat is applied to the fractionator, the expansion tends to lift the cold inlet pipe, but not sufficient to release all the compression of the spring. The spring anchor automatically takes care of the vertical movement of the pipe resulting from expansion or contraction of the fractionator.

## Large Packing Order for Pipe Line Installation Is Placed

The Packing Engineering Corp., of Cranford, N. J., manufacturers of Ace-O-Pax Plastic Packing, has been awarded the order for the plunger packing for the 45 Worthington-Simpson (London) 6¾ by 24-in. pipe line pumps to be installed in the booster stations of the Iraq Petroleum Company's 1200-mile pipe line. The order consists of 240 Ace-O-Pax installations and is claimed to be one of the largest orders ever placed by a single pipe line company.

This packing is being manufactured in the newly completed plant of the company to which they moved last month. The packing on this order will be the first made in the new plant.

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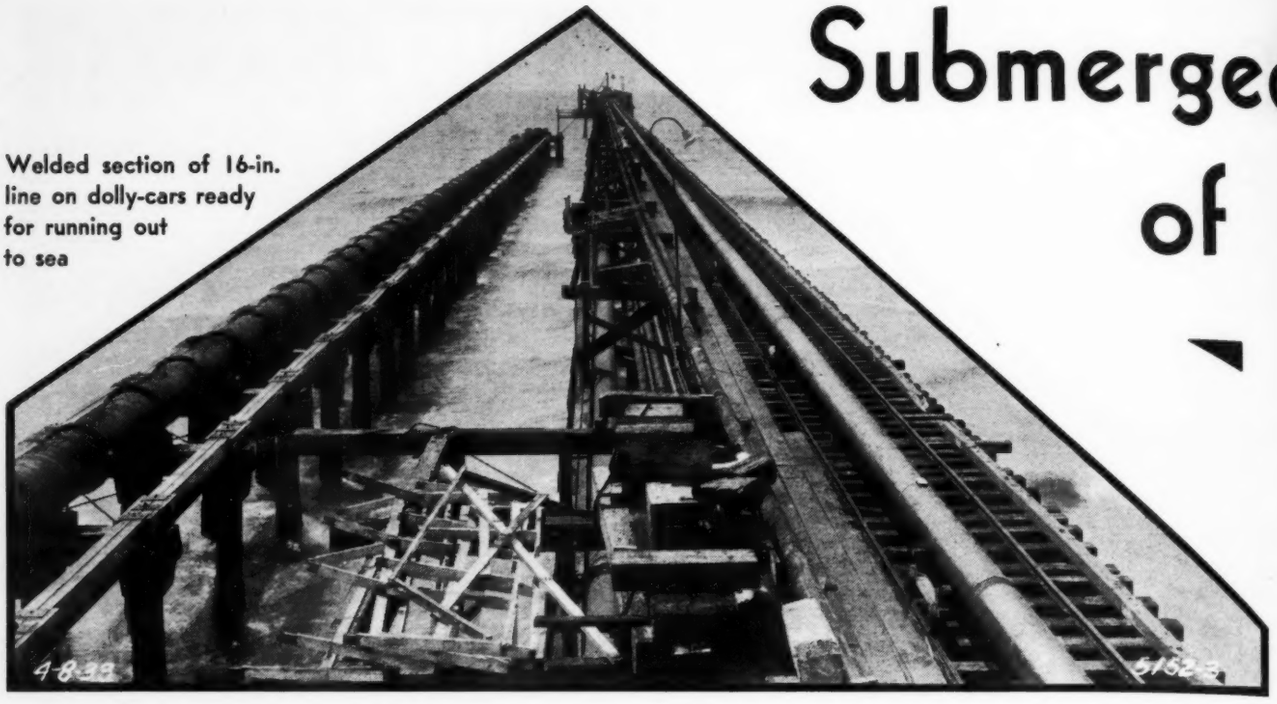


Welded section of 16-in. line on dolly-cars ready for running out to sea

## The use of a 12-in. submarine discharge hose reduces loading time

IN order to eliminate all delays due to weather conditions and to provide a consistently reliable means of loading tankers with products from its El Segundo refinery, a submerged pipe line has been constructed by the Standard Oil Company of California that extends from the end of an old wharf to water of sufficient depth to accommodate any draft vessel. Originally this wharf extended 4000 ft. into the Pacific ocean, but an exceptionally heavy storm demolished the outer 1800 ft. and showed the advisability of using a pipe line laid on the floor of the ocean to a more suitable point of loading. Besides making it practicable to load in any kind of weather, the submarine pipe line also was readily carried out to a depth of 50 ft. of water, where tankers of any size could be loaded.

The El Segundo refinery is situated near the shore and somewhat higher in elevation. Products to be shipped are carried by gravity through a 20-in. line down to the wharf, whence a 16-in. line has been used to convey them to the seaward end. This wharf is 2200 ft. in length and the new pipe line was carried from its end for another 3200 ft., 16-in. pipe being used for this extension. A 12-in. rubber hose attached to the outer end of the pipe is 175 ft. in length and lies on the bottom of the ocean when not in use. It is connected at its end with a light buoy by means of a chain and is raised to the surface of the water when a ship is to be loaded.

Though all the tankers have their own anchors, five mooring buoys have been arranged at convenient intervals around the hose-marker. Each of these buoys is attached to a 16,000-lb. weight with heavy anchor chains, and when a ship is properly tied to this equipment it will ride safely in almost every kind of weather. Only in the most extreme cases is loading or unloading liable to be interrupted.

Although the loading end of the pipe line is more than a mile from shore, only the 3200 ft. beyond the end of the wharf had to be laid. Contamination of the various products to be loaded and the possibility of oil leaks that might cause pollution of near-by beaches were provided against by laying a second line, 8 in. in diameter, parallel to the main 16-in. line. These two lines were connected at the outer end and permit circulation so that water may be kept in the line when it is not in service. Both lines were welded into sections on the wharf and launched as soon as the sections were made up and tested. The first section was 2000 ft. in length, and the process of launching was comparatively simple, since a railroad track was already in place on the wharf and dolly-cars were available for the work. The pipe was therefore placed on the cars with the second section of 1200 ft. welded together and lying alongside together with equal sections of the 8-in. pipe. The only problem was to get the pipe to the bottom of the ocean and at the same time turn a small horizontal angle as it took off from the end of the wharf. This angle was necessary since much of the demolished portion of the wharf was of steel and concrete construction and the debris from its wreckage was still strewn around the present end of the pier. By swinging the line at a small angle as it left the wharf, the debris could be avoided. As an added precaution, the line's alignment or right-of-way was walked by a diver and a number of pieces of debris thus discovered were pulled out of the way by a company ship. While such obstructions might be of little consequence under ordinary conditions there was always the possibility of interference with pulling the line if not removed. Guide rollers were finally decided upon to force the pipe to leave the wharf at the proper angle. When all preparations were completed, the company ship "El Segundo" was anchored in line with the new line about 500 ft. beyond its outer end. A heavy steel cable was brought from the ship to the pier head, fastened to the end of the pipe, and then pulled back by means of a large towing engine of the ship.

It was estimated that the 16-in. seamless steel pipe used for the main line, which weighed 92 lb./ft., weighed but three to four lb./ft. in the water. The ease with which this was dragged along the floor of the ocean can readily be understood, but in order to insure absolute control at all times, a temporary telephone line was laid from the ship to the

# Pipe Line Facilitates Loading Tankers

By
WALLACE A. SAWDON
Petroleum Engineer
Los Angeles

Photographs courtesy of
Standard Oil Bulletin

Ready to connect the submerged 16-in. line with the sea end of the line on the old wharf

wharf. This line, together with a whistle system and a semaphore, provided a means of complete control of the operation at all times and prevented any pull on the line being exerted except when desired.

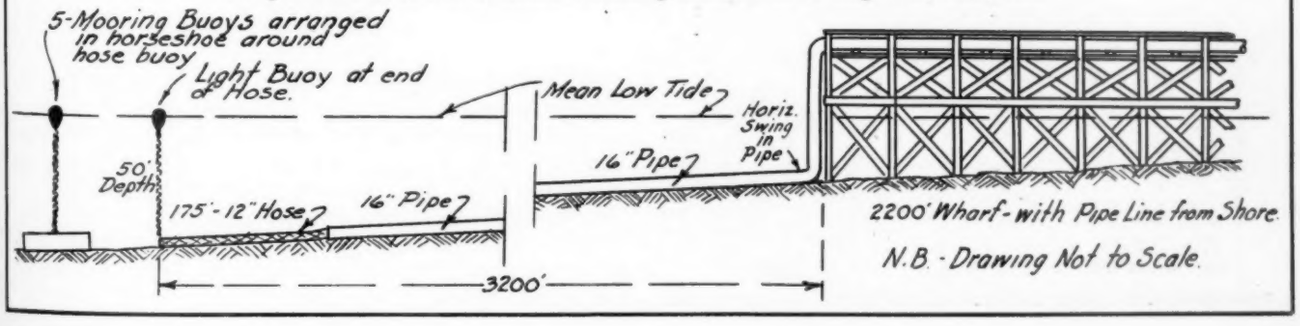
As soon as the first section was launched, the second section of pipe, which was welded and ready to run, was rolled over and on to the cars. The two sections were then welded together and the pulling of the line immediately continued. The entire job of running the 16-in. main line, including the tying in of the two sections and attaching to the riser at the end of the wharf, required only seven hours, and the actual pulling speed while the line was in motion was about that of a slow walk.

Each section of pipe was tested to 500 lb. per sq. in. as soon as it was welded together. Actual pressure on the line, however, will never exceed 150 lb. per sq. in., since the strength of the hose is not capable of withstanding much more than this amount. Assurance of the workmanship in the welds, however, was most desirable as any repair work on a submerged line of this type is rather inconvenient, also, as already mentioned, pollution of beaches by oil leakage had to be provided against, so every precaution was taken to insure the best possible job being obtained.

In a submarine line of this type, the hose at the end is the factor that controls the rate at which boats can be loaded or unloaded. It is the general practice to load tankers through an 8-in. hose but as the difference in elevation between the intake of the 20-in. line at the refinery and the discharge end of the hose at the ship is too small to give a head sufficient for the desired rate of discharge, a special rubber hose 12 in. in diameter was designed. This is probably the first 12-in. submarine oil-loading hose to be used and while it is rather heavy for ships to handle conveniently, it assists greatly in cutting down the loading time.

The 175 ft. of 12-in. hose used at the end of the El Segundo submarine pipe line weighs approximately seven tons and has a bursting strength of 800 lb. per sq. in. By reason of the large hose diameter, a ship can be loaded by gravity from the shore tanks at the rate of 6000 bbl. an hour, which is estimated to be about 1800 bbl. an hour faster than would be possible with an 8-in. hose used under identical conditions.

Diagramatic sketch of submarine loading terminal at El Segundo, California


5-Mooring Buoys arranged in horseshoe around hose buoy
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50' Depth
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16" Pipe
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# BOOKS *of the* TRADE

THE PETROLEUM REGISTER, an international directory, statistical record and equipment catalogue of the petroleum industry, has issued its 1933 book, the price of which is $10.00. It may be obtained by writing to The Petroleum *Register*, 165 Broadway, New York City. It presents detailed reports of United States and foreign companies, including producers, refiners, marketers, jobbers, compounders and grease manufacturers, natural gasoline operators, pipe lines, petroleum personnel, oil associations and equipment manufacturers, also royalty companies, drilling contractors and trade names.

* * *

The American Institute of Mining and Metallurgical Engineers, 29 West 39th Sreet, New York, has published "TRANSACTIONS A.I.M.E. (1933), PETROLEUM DEVELOPMENT AND TECHNOLOGY." The price of the volume is $5 net; bound in cloth; 426 pages. It is the eighth of the Petroleum Development and Technology series of the petroleum division of A.I.M.E., and contains papers and pertinent discussion presented before sessions held in Los Angeles in July, Ponca City in October, and New York in February of 1932 and 1933, respectively.

Chapter 1, on Stabilization, includes a review of petroleum stabilization in 1932, by Earl Oliver, a feature of which is a bibliography (121 items) of articles relating to stabilization that suggest its trend. There is also a symposium on "Reservoir Energy: Its Source, Ownership and Utilization in the Production of Petroleum," led by Dr. Joseph B. Umpleby. In Chapter II on Economics, Sidney Swensrud presents an interesting article entitled "Factors Affecting the Demand for Gasoline and Crude Oil Over the Next Few Years: A Study of Automobiles in Use."

Among the papers on Production Engineering or Engineering Research subjects (Chapter III; 193 pages) are the following: "The Killing of Milham Elliott No. 1 and Continental Elliott No. 12-8 wells, Kettleman Hills, California," by R. Silent and N. A. Rousselot; "Reservoir and Bottom-Hole Producing Pressures as a Basis for Proration," by C. V. Millikan; "Subsurface Pressures in Oil Wells and Their Field of Application," by D. G. Hawthorn; "Calculation of Pressure Drops in Flowing Wells," by T. V. Moore and R. J. Schilthuis; "Mechanics of Water Movement in Natural and Artificial Flooding of Oil Sands," by K. B. Nowels, and "The Mechanics of Porous Flow Applied to Water-flooding Problems," by R. D. Wyckoff, H. G. Botset and M. Muskat.

Chapter IV is a symposium on production in 1932. Chapter V is a summary by Walter Miller of developments in refinery engineering during 1932.

* * *

"KANSAS OIL AND GAS LAWS, 1933," a book for those interested in oil and gas development in Kansas, has been issued by the Bridgeport Machine Company of Wichita, Kan. The book contains the principal lease, production and development and pipe line laws of the state, including the laws enacted by the last legislature. Also included are references to court decisions, as well as the principal rules and orders of the State Public Commission now in effect and pertaining to oil and gas development.

### *Trade Literature*

NATIONAL BULLETIN No. 20, published by the National Tube Company, Pittsburgh, Pa., has been prepared on the interesting subject of 4 per cent to 6 per cent Chromium Seamless Pipe and Tubes. Chapters include discussions of the advantage, applications, high temperature properties, stability, resistance to corrosion and oxidation and general features of these pipes and tubes.

* * *

LINK-BELT VIBRATING SCREEN, an improved method for the effective, economical reclaiming, degassing and cleaning of rotary mud, is covered in Folder No. 1372 of the Link-Belt Company, Philadelphia, Pa. Among the new features are the use of adjustable deflectors for regulating the distribution of mud fluid over the screening surface; special tubular rubber supports upon which the screen cloth rests and a steel mud-collecting tank for conducting the screened mud to flume leading to pump suction pit.

* * *

"PRACTICAL INFORMATION ON THE USE AND CARE OF WIRE ROPE," a booklet that has been issued for several years by A. Leschen & Sons Rope Company, is just off the press in a revised edition. The booklet may be obtained by writing to the company at 5909 Kennerly Avenue, St. Louis, Mo., and will be sent complimentary to any individual or company interested in getting maximum returns on their wire rope investment.

* * *

SMALL SPRAY-TYPE COOLING TOWERS, both forced and natural draft, are described in a new bulletin issued by The Marley Company, Kansas City, Mo. A more complete range of sizes and types, many improvements in design, complete details of construction and installation and operation are all fully covered in this new bulletin.

* * *

LUBRICATED PLUG VALVES are the subject of a recently published circular of the Crane Co., 836 South Michigan Avenue, Chicago, Ill. This circular, given the number 252, is of the loose-leaf type, ready for insertion in the company's standard binder.

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"THE IDEAL PIPE FOR WATER WELLS," an attractive folder, has been published by Republic Steel Corporation, Youngstown, Ohio. It explains the features of Republic Electric Weld Pipe that render it so excellently adapted for well drilling.


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# INDEX *to* ADVERTISERS


A

Adolphus Hotel
American Cable Co.
American Meter Co.
American Sheet & Tin Plate Co. 6
American Steel & Wire Co. 58
Armstrong Bros. Tool Co. 1
Axelson Manufacturing Co. Ltd. 65
53

B

Baroid Sales Co. 61
Bowen Air Lines 61
Bradford Motor Works 59
Broderick & Bascom Rope Co.
Buccaneer Hotel 60

C

Chaplin-Fulton Mfg. Co., The 58
Continental Supply Co., The 50
Cooper-Bessemer Corp., The
Crane Co. 2

D

Dresser, S. R., Mfg. Co.

E

Electric Controller & Mfg. Co., The 52
Ethyl Gasoline Corporation

F

Flexible Steel Lacing Co. 57
Frick-Reid Supply Corp.

G

Gaso Pump & Burner Mfg. Co. Inside Front Cover
General Electric Co.
Goodyear Tire & Rubber Co. 31
Guiberson Corp., The

H

Halliburton Oil Well Cementing Co. 42
Harrisburg Pipe & Pipe Bending Co. 56
Haynes Stellite Co.
Hazard Wire Rope Co.
Hughes Tool Co. Back Cover

J

Jones & Laughlin Steel Corporation 4
Jones, S. M., Co., The 66

K

Kinley, M. M., Co. 56
Kobe, Inc. 61

L

Leschen, A., & Sons, Rope Co. 8
Lincoln Electric Co.
Linde Air Products Co.
Lufkin Foundry & Machine Co.
Lufkin Rule Co.

M

Martin-Decker Development Co., Ltd.
Mason-Neilan Regulator Co.
Mayfair Hotel 65
Merco-Nordstrom Valve Co. Front Cover
Metric Metal Works 6
Mepham, Geo. S., & Co. 11
Missouri-Kansas-Texas Railroad Company 64

N

National Supply Companies, The 32
National Tube Co.
National Tube Co. (Stainless) 16
Norris, W. C., Manufacturer

O

Oil Well Supply Co. 41

P

Parkersburg Rig & Reel Co., The 37
Petroleum Equipment Co. 60 and 65
Petroleum Rectifying Co. Inside Back Cover
Pittsburgh Equitable Meter Co. Front Cover
Price-Trawick, Inc.

R

Republic Steel Corp. 15

S

S. K. F. Industries, Inc. 39
South Chester Tube Co.
Spang, Chalfant Co., Inc.
Sperry-Sun Well Surveying Co. 65
Struthers Wells-Titusville Corp. 5

T

Texacone Co. Inc., The 64
Thermoid Rubber Co.
Titusville Iron Works Co. 5
Toledo Pipe Threading Machine Co., The 57
Tretolite Company
Trimont Mfg. Co. 59

U

Union Wire Rope Corp. 60
United Gas Public Service Co.

W

Wyatt Metal & Boiler Works

Y

Youngstown Sheet & Tube Co. 49